*Journal of the Adelaide Botanic Gardens* 29 (2015) 1–6


# Lichenicolous species of the Ascomycete genus *Arthonia* Ach. from Kangaroo Island

*G. Kantvilas*[a] *& M. Wedin*[b]

[a] Tasmanian Herbarium, Tasmanian Museum & Art Gallery,
P.O. Box 5058, UTAS LPO, Sandy Bay, Tasmania 7005
*E-mail:* Gintaras.Kantvilas@tmag.tas.gov.au

[b] Department of Botany, Swedish Museum of Natural History,
P.O. Box 50007, SE-104 05 Stockholm, Sweden
*E-mail:* Mats.Wedin@nrm.se

## Abstract

Three lichenicolous species of *Arthonia* Ach. are reported from Kangaroo Island, South Australia. Two are described as new: *Arthonia caliciae* Kantvilas & Wedin grows on the thallus of the lignicolous species *Calicium tricolor* F.Wilson, whereas *Arthonia insularis* Kantvilas & Wedin grows on the saxicolous *Caloplaca eos* S.Y.Kondr. & Kärnefelt. A third species, the widespread *A. intexta* Almq., infects the apothecia of the saxicolous crustose lichen, *Lecidella sublapicida* (Knight) Hertel. A key to the eight lichenicolous species of *Arthonia* recorded for Australia is provided.

**Key Words:** biodiversity, lichens, lichen parasites, new taxa, Arthoniaceae, South Australia.

## Introduction

*Arthonia* is a cosmopolitan genus of ascomycete fungi that occurs in most habitats, ranging from dry steppes and savannahs to closed wet forest, and from littoral to alpine elevations. It has been estimated to contain approximately 400 species (Kirk et al. 2001), but this is an old and certainly outdated estimate. It is obvious both from the large variation in morphological traits (Grube & Matzer 1997, Sundin & Tehler 1998, Wedin & Hafellner 1998, Ihlen & Wedin 2008) and molecular phylogenies (Frisch et al. 2014) that *Arthonia* in its current circumscription is not monophyletic, and it is likely that a substantial change in its generic concept and delimitation will eventually occur. The majority of species are lichenised with the filamentous green alga *Trentepohlia*, and can be found on bark, wood, rocks or living leaves. These species are well represented in the Australian biota with 40 taxa recorded by McCarthy (2015). This figure is undoubtedly a very large underestimate, because the genus remains poorly collected and largely unstudied in the region. Most Australian herbaria hold significant numbers of specimens identified to genus only or tentatively identified to species using some of the more accessible Northern Hemisphere publications, such as Coppins & Aptroot (2009), Grube (2007) and Willey (1890), or the account of the genus for New Zealand (Galloway 2007).

Some species of *Arthonia* may be non-lichenised or weakly or only putatively lichenised, and occur as saprophytes on bark, although it is sometimes difficult to confirm this lifestyle without detailed anatomical study. Another highly diverse group within *Arthonia* comprises lichenicolous species, growing on the thalli of a wide range of fruticose, foliose or crustose genera. Collections of such species are also well-represented in Australian herbaria but are largely unstudied and filed under the name of the host species. However, a few of these have been studied and described on the basis of Australian collections, for example, Kondratyuk (1996), Wedin (1993), Wedin & Hafellner (1998) and Kantvilas & Vězda (1992). Based on the literature, McCarthy (2012) records five lichenicolous species for Australia. It is three species from this group that are the focus of the present study.

## Methods

The study is based on collections of the first author, housed in the Tasmanian Herbarium (HO), but with some duplicates distributed to other herbaria, as cited in the text, and on comparisons with reference herbarium material (also as cited). The descriptions are based on hand-cut sections of the ascomata, mounted in water, 15% KOH, lactophenol cotton blue and Lugols Iodine, with (K/I) or without (I) pretreatment in KOH, and examined at high-power with a light microscope. Measurements of ascospores are based on more than 50 observations for each taxon and are presented in the form 5$^{th}$ percentile–*average*–95$^{th}$ percentile; outlying values are given in brackets.

## Taxonomy

**1. *Arthonia caliciae* Kantvilas & Wedin, *sp. nov.***

*Hospite singulari (*Calicio tricolori *F.Wilson), ascosporis hyalinis, ellipsoideis, uni-septatis, 10–14 µm longis, 3–5 µm latis et ascis omnino non-amyloideis recognita.*

**Mycobank no.:** MB 812915.

**Typus:** South Australia, Kangaroo Island: Billy Goat Falls, 35°42'S 136°55'E, 200 m alt., on thallus of *Calicium tricolor* on dead wood in dry sclerophyll forest, 20 Sep. 2012, *G. Kantvilas 773/12* (holo: HO; iso: AD, S).

Growing on the scurfy crustose thallus of *Calicium tricolor* F.Wilson, *thallus* lacking, trebouxioid photobiont cells of the host lichen often penetrating the base of the ascomata. *Ascomata* irregularly roundish, 0.12–0.3 mm wide, blackish brown to black, convex, minutely scabrid-verruculose, immarginate, slightly basally constricted to sessile, in section 60–120 µm thick, lacking any differentiated exciple. *Hypothecium* hyaline to pale olive-brown, poorly differentiated from the hymenium. *Hymenium* 30–55 µm thick, diffusely pale olive-brown, intensifying olive-greenish in K, I+ red, K/I+ blue, overlain by a more intensely pigmented epihymenial layer c. 5 µm thick; paraphysoids highly branched and anastomosing, rather indistinct, remaining rather coherent in K, c. 1 µm thick, with apices neither expanded nor capitate but strongly conglutinated with pigment; asci 8-spored, 23–38 × 12–20 µm, of the *Arthonia*-type: broadly clavate to subglobose, mostly with a short 'foot' at the base and a well-developed tholus I–, K/I– , lacking an amyloid ring-structure; apex of ascoplasm variable with age, concave, rounded or extending in a beak-like ocular chamber. *Ascospores* hyaline, 1-septate, 10–*11.3*–13 (–14) × (3–) 4–*4.7*–5 µm, narrowly ellipsoid, typically with the upper cell a little larger and the septum slightly constricted. *Pycnidia* immersed at the base of the ascomata; conidia rod-shaped, 4–5 × 0.5 µm. **Fig. 1, 2A–E.**

*Etymology.* The specific epithet refers to the unusual host of this new species.

*Remarks. Arthonia caliciae* is characterised by its completely hyaline, ellipsoid, 1-septate ascospores, its totally non-amyloid asci, and by its host. Most lichenicolous fungi that grow on species of *Calicium* are themselves other calicioid fungi; for example, species of *Chaenothecopsis* or *Microcalicium*. Thus *Arthonia caliciae* is the first species of *Arthonia* to be reported growing on a *Calicium*. Among other *Arthonia* species known to occur on lichens related to the host (i.e. the non-mazaediate Caliciaceae; Wedin et al. 2002) are *A. epimela* (Almq.) I.M.Lamb, which grows on the thallus of *Amandinea punctata* (Hoffm.) Coppins & Scheid. This species differs from *A. caliciae* by the considerably larger ascomata (c. 0.4–0.6 mm diam.) and the hyaline hymenium. *Arthonia punctella* Nyl. grows on various crustose lichens, including *Diplotomma alboatrum* (Hoffm.) Flot., but is clearly parasitic and has ascospores that turn brown and verrucose. None of these species are currently known from Australia. Indeed few calicioid species are associated with *Arthonia* sens. lat.; *Chaenothecopsis vainioana* (Nádv.) Tibell (Tibell 1981, 1999), which is associated with both free-living *Trentepohlia* and *Trentepohlia*-containing lichens, is an exception.

**Fig. 1. *Arthonia caliciae***, seen as abundant black, speck-like apothecia on the pale yellowish thallus of *Calicium tricolor*. The stalked, mazaediate, trumpet-shaped ascomata of the *Calicium* are also present. — Scale bar: 1 mm.

The new species is known only from the type collection, growing on decorticated, bleached, rotting eucalypt lignin in dry open eucalypt forest. Other species growing on the same substratum included *Calicium abietinum* Pers., *C. salicinum* Pers., *Ochrolechia gyrophorica* (A.W.Archer) A.W.Archer & Lumbsch, *Ramboldia stuartii* (Hampe) Kantvilas & Elix, *Lecidella xylogena* (Müll.Arg.) Kantvilas & Elix and *Caloplaca wilsonii* S.Y.Kondr. & Kärnefelt.

**2. *Arthonia insularis* Kantvilas & Wedin, *sp. nov.***

Arthoniae anjutii A. sytnikii*que similis et item ascis non-amyloideis et ascosporis brunnescentibus, 10–18 µm longis, 5–9 µm latis sed thallum* Caloplacae eos *S.Y.Kondr. & Kärnefelt incolens et apotheciis non-immersis, gallas non-formantibus vel thallum hospitis non decolorantibus.*

**Mycobank no.:** MB 812916.

**Typus:** South Australia, Kangaroo Island, summit of bluff W of Windmill Bay, 35°51'S 138°07'E, 40 m alt., on thallus of *Caloplaca eos* on granite boulders in coastal heathland, 17 Sep. 2012, *G. Kantvilas 506/12* (holo: HO; iso: AD, KW, S).

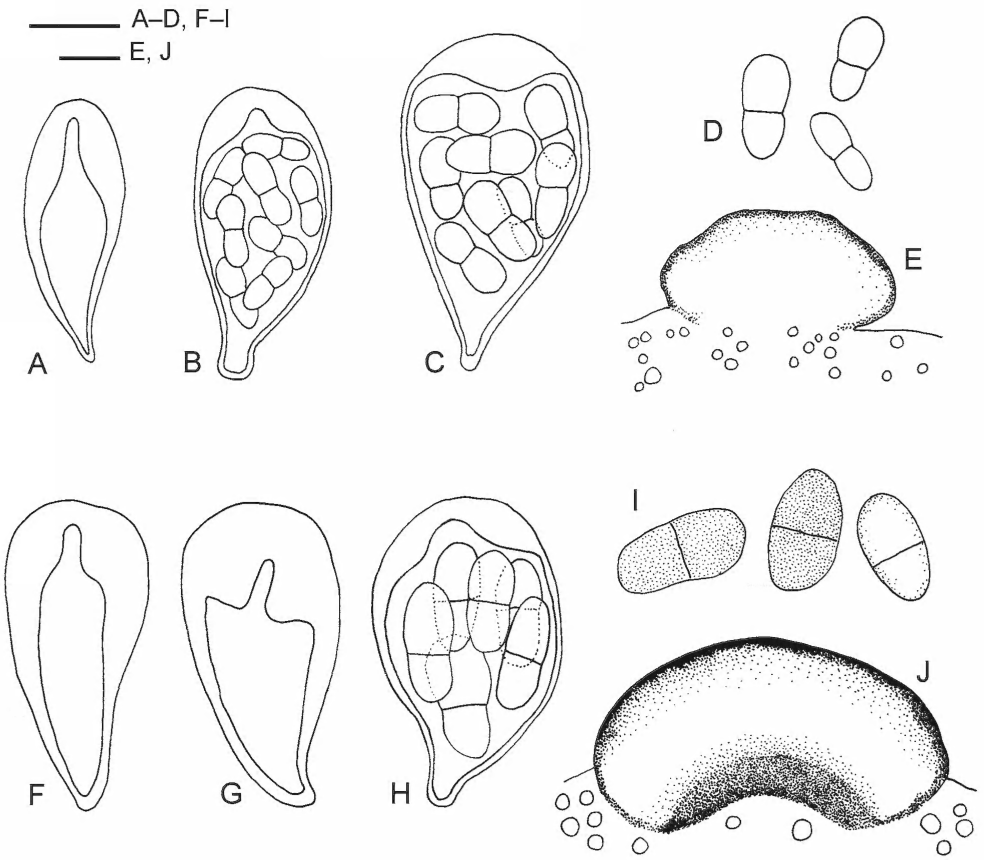


**Fig. 2.** Anatomy of the new species. **A–E** ***Arthonia caliciae***: **A–C** non-amyloid asci mounted in K/I; **D** ascospores; **E** transverse section of ascoma (semi-schematic). **F–J** ***A. insularis***: **F–H** non-amyloid asci mounted in K/I; **I** ascospores; **J** transverse section of ascoma (semi-schematic). — Scale bars: A–D, F–I = 10 µm; E, J = 40 µm. — **A–E** *G.Kantvilas 773/12*. **F–J** *G.Kantvilas 506/12*.

Growing on the thallus or, very rarely, the apothecia of *Caloplaca eos* S.Y.Kondr. & Kärnefelt, *thallus* lacking. *Ascomata* roundish, 0.05–0.4 mm wide, black, slightly to strongly convex, rarely ± plane, immarginate, at first immersed in the cortex of the host, soon emergent and adnate, in section 80–150 µm thick. *Hypothecium* dilute reddish brown, K+ deep olive-grey, poorly differentiated from the hymenium, subtended by a cupulate, excipulum-like tissue 10–20 µm thick, composed of densely packed, rather cellular hyphae, deep reddish brown, K+ dark olive-grey. *Hymenium* 50–60 µm thick, hyaline to diffusely pale reddish brown, K+ olive-grey, I+ red, K/I+ blue, overlain by a dark reddish brown, K+ dark olive-grey epihymenial layer c. 10 µm thick; paraphysoids highly branched and anastomosing, coherent in K, 2–3 µm thick, with apices neither expanded nor capitate but strongly conglutinated with pigment; asci initially 8-spored but usually with several spores aborted at maturity, 20–45 × 15–25 µm, of the *Arthonia*-type: broadly clavate to subglobose, mostly with a short 'foot' at the base and a well-developed tholus I–, KI–, lacking an amyloid ring-structure; apex of ascoplasm variable with age, concave, rounded or extending in a beak-like ocular chamber. *Ascospores* 1-septate, hyaline at first but soon becoming pale reddish brown, K+ olive-grey, (10–) 12–*14.3*–17 (–18) × 5–*7.2*–8.5 (–9) µm, oblong-ovoid to ellipsoid, mostly with the upper cell a little larger, not markedly constricted at the septum; wall becoming minutely papillate in older spores. *Pycnidia* immersed at the base of the ascomata; conidia narrowly fusiform to rod-shaped, 4–6 × 1–1.5 µm. **Fig. 2F–J, 3.**

*Etymology.* The specific epithet refers to the island provenance of the type collection.

*Remarks.* Species of Teloschistaceae are known to serve as hosts for several species of *Arthonia*. The common and widespread *A. molendoi* (Heufl. ex Frauenf.) R.Sant., which occurs on various Teloschistaceae, differs from *A. insularis* by having smaller ascomata (rarely more than 0.2 mm diam.), somewhat smaller ascospores (c. 12–15 × 5–6 µm) that do not become brownish and papillate, and asci with an apical K/I+ blue ring-structure. There are two further *Arthonia* species known to occur on Teloschistaceae (Kondratyuk 1996) that share with *A. insularis* similar-sized ascospores and entirely non-amyloid asci, but which differ from the new species by being clearly parasitic: *A. sytnikii* S.Y.Kondr., described from Australia (Adelaide), forms distinct, raised galls on its host *Xanthoria ligulata* (Körb.) P.James, whereas *A. anjutii* S.Y.Kondr. & Alstrup, which grows on species of *Teloschistes* in the highlands of Victoria, differs by causing ± discoloured and sometimes almost deformed areas on its host. The latter in particular has ascomata that are initially immersed, but break through the host thallus, frequently retaining some host cortical tissue as a thin, discontinuous veil that is also discernible in thin transverse sections.

The new species is known only from the type locality, where it grew on granite boulders in windswept, exposed, low coastal heathland. It infected the thallus of *Caloplaca eos*, associated with other species of the genus, including *C. gallowayi* S.Y.Kondr., Kärnefelt & Filson and *C. tomareeana* S.Y.Kondr. & Kärnefelt. Significantly, the thalli of these related lichens were not infected by the *Arthonia.*

*Comparative material of* A. anjutii *studied:*

New South Wales: Kosciuszko Nat. Park, Charlotte´s Pass, on *Teloschistes fasciculatus*, 6.iv.1981, *L. Tibell 12114* (UPS).

Victoria: "The Sentinel" peak, SE of Lake Tali Karng, Mt Wellington area, 1450 m alt., on *Teloschistes velifer*, 12.iii.1966, *J.H. Willis s.n.* (MEL); Bogong High Plains, Mt Cope, on *Teloschistes velifer*, 19.i.1966, *R. Filson 8104* (MEL); Bogong High Plains, Spion Kopje ridge, 1820 m alt., on *Teloschistes velifer*, 23.i.1967, *R. Filson 9533* (MEL).

### 3. *Arthonia intexta* Almq.

Kongl. Svenska Vetensk-Akad. Handl. 17(6): 60 (1880).

Growing within the apothecia of *Lecidella sublapicida* (Knight) Hertel, *thallus* lacking. *Ascomata* poorly differentiated from those of the host. *Hymenium* entirely within and at length completely supplanting the hymenium of the host, I+ red, K/I+ red; paraphysoids highly branched and anastomosing, rather indistinct, coherent in K, 1.5–2 µm thick, with apices internally olive-brown, K+ olive-grey, 2–5 µm wide; asci 8-spored, 27–33 × 10–15 µm, of the *Arthonia*-type: broadly clavate, mostly with a short 'foot' at the base and a well-developed tholus I–, K/I– , lacking an amyloid ring-structure. *Ascospores* hyaline, (1–) 2-septate, 10–*11*–13 (–14) × 3–*4*–5 µm, narrowly ellipsoid. *Pycnidia* immersed in the apothecia of the host; conidia fusiform, 4–5 × 1–1.2 µm.

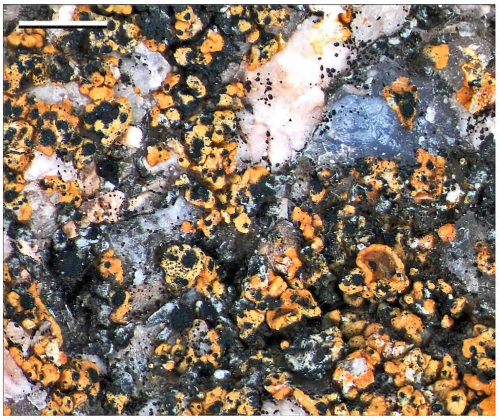

**Fig. 3.** ***Arthonia insularis***, seen as abundant black, speck-like apothecia on the orange thallus and apothecium of *Caloplaca eos*. — Scale bar: 1 mm.

*Remarks.* This remarkable species is characterized mainly by its unique habitat, and by the 2-septate, hyaline ascospores. It was first observed rather fortuitously in the course of routine sectioning of a specimen of *Lecidella sublapicida*. In earlier stages of its development, the asci of the *Arthonia* are interspersed amongst the asci of the *Lecidella*, and are easily distinguished by their different amyloid reactions, those of *Lecidella* being K/I+ blue. In later stages, the normally black, discoid apothecia of *Lecidella* become deformed, strongly contorted and convex, and their margin becomes rather indistinct. In such apothecia, the asci of the *Arthonia* dominate the whole apothecium, although the typical blue-green pigmented, *Lecidella*-type excipulum and the yellow-brown hypothecium remain evident. For a description of *L. sublapicida* see Kantvilas & Elix (2013). The observation of pycnidia was entirely by chance; they were seen in just one of a large number of apothecial sections made in the course of compiling the above description.

The description given here is based solely on the single Kangaroo Island specimen studied. It accords well with accounts of the species in the Northern Hemisphere, although European authors, for example Coppins & Aptroot (2009), Triebel (1989) and Ihlen & Wedin (2008), report ascospores that are somewhat larger, 11–20 × 3–6 µm.

The species was collected on Kangaroo Island as part of a large specimen of *Lecidella sublapicida*, growing on sunny rocks in pasture at the margins of mallee woodland. Other lichens present included *Lecidea sarcogynoides* Körb. and *Diploschistes gyrophoricus* Lumbsch & Elix.

*Specimen examined:*

South Australia, Kangaroo Island: Cape Willoughby Rd, 35°50'S 138°06'E, 110 m alt., 29 Sep. 2011, *G. Kantvilas 325/11* (HO).

## Provisional key to the lichenicolous species of *Arthonia* recorded for Australia

The study of lichenicolous *Arthonia* in Australia is in its infancy and it is very likely that many more species are yet to be discovered. Consequently, it is recommended that this key is used in conjunction with others, such as those of Clauzade et al. (1989) and Ihlen & Wedin (2008).

**1.** Ascomata orange-red, infused with a K+ purple pigment, forming necrotic patches on the thallus of *Pseudocyphellaria*; ascospores 1-septate, becoming brownish, 10–14.5 × 4–5.5 µm . . . . . ***A. pseudocyphellariae*** Wedin

**1:** Ascomata brown to black, or poorly differentiated

**2.** Ascomata poorly differentiated from host tissues, entirely immersed within the apothecia of *Lecidella* species; ascospores (1–) 2 (–3)-septate, hyaline, 10–20 × 3–6 µm . . . . . 3. ***A. intexta***

**2:** Ascomata distinct; ascospores persistently 1-septate

**3.** Ascomata discrete and emergent from the thallus of the host

**4.** Ascomata minute, 0.1–0.15 mm wide, growing on the thallus of *Sagenidium molle* in cool temperate rainforest; ascospores hyaline, 6–9 × 2–2.2 µm . . . . . ***A. sagenidii*** Vězda & Kantvilas

**4:** Ascomata and ascospores generally larger, not on *Sagenidium*

**5.** Ascomata flecklike, 0.3–1.5 (–2) mm wide, frequently confluent, growing on the thallus of *Lobaria*; hypothecium dark brown; ascospores hyaline, 11–15 × 3–4 µm . . . . . ***A. subconveniens*** Nyl.

**5:** Ascomata roundish and discrete, 0.05–0.4 mm wide, not on *Lobaria*; hypothecium hyaline to pale brownish

**6.** Ascomata growing on the thallus of *Calicium*; ascospores hyaline, 10–14 × 3–5 µm . . . . . 1. ***A. caliciae***

**6:** Ascomata growing on the thallus of *Caloplaca*; ascospores becoming brown, 10–18 × 5–9 µm . . 2. ***A. insularis***

**3:** Ascomata inducing galls or necrotic patches on the host

**7.** Ascomata 0.15–0.45 mm wide, inducing galls on the thallus of *Xanthoria*; hypothecium hyaline; ascospores hyaline, 8–13 × 3–5 µm . . . . . ***A. sytnikii*** S.Y.Kondr.

**7:** Ascomata 0.25–0.35 mm wide, forming discoloured patches on the thallus of *Teloschistes*; hypothecium dark brown to black-brown; ascospores becoming brown, 11–16.5 × 4.5–7 µm . . . . . ***A. anjutii*** S.Y.Kondr. & Alstrup

## Acknowledgements

We thank Jean Jarman for the photographs that illustrate this paper, and for preparing the line drawings for publication. Herbaria cited are acknowledged for the speedy loan of reference material. Special thanks go to our colleague, Sergey Kondratyuk, who first drew our attention to the occurrence of *Arthonia insularis* on a specimen of *Caloplaca* sent to him for study.

## References

Coppins, B.J. & Aptroot, A. (2009). *Arthonia* Ach. (1806). In: Smith, C.W., Aptroot, A., Coppins, B.J., Fletcher, A, Gilbert, O.L., James, P.W. & Wolseley, P.A. (eds), *The lichens of Great Britain and Ireland*, 153–171. (British Lichen Society: London).

Clauzade, G., Diederich, P. & Roux, C. (1989). Nelikenigintaj fungoj likenogaj. Ilustrita determinilibro. *Bulletin de la Société de Provence. Numéro spécial* 1: 1–142.

Frisch, A., Thor, G., Ertz, D. & Grube, M. (2014). The Arthonialean challenge: restructuring Arthoniaceae. *Taxon* 63: 727–744.

Galloway, D.J. (2007). *Flora of New Zealand lichens. Revised second edition*. (Manaaki Whenua Press: Lincoln).

Grube, M. (2007). *Arthonia*. In: Nash, T.H., Gries, C. & Bungartz, F. (eds), *Lichen flora of the Greater Sonoran Desert region* 3: 39–61. (Lichens Unlimited: Tempe, AZ).

Grube, M. & Matzer, M. (1997). Taxonomic concepts of lichenicolous *Arthonia* species. *Bibliotheca Lichenologica* 68: 1–17.

Ihlen, P.G. & Wedin, M. (2008). An annotated key to the lichenicolous Ascomycota (including mitosporic morphs) of Sweden. *Nova Hedwigia* 86: 275–365.

Kantvilas, G. & Elix, J.A. (2013). The lichen genus *Lecidella* (Lecanoraceae), with special reference to the Tasmanian species. *Muelleria* 31: 31–47.

Kantvilas, G. & Vězda, A. (1992). Additions to the lichen flora of Tasmania. *Telopea* 4: 661–670.

Kirk, P.M., Cannon, P.F., David, J.C. & Stalpers, J.A. (2001). *Dictionary of the fungi*. (CABI Publ.: Wallinford, Oxon).

Kondratyuk, S.Y. (1996). Four new species of lichenicolous fungi. In: Wasser, S.P. (ed.), *Botany and mycology for the next millennium: Collections of scientific articles devoted to the 70th anniversary of academician K.M. Sytnik*, pp. 309–315. (National Academy of Sciences of Ukraine: Kiev).

McCarthy, P.M. (2012). *Checklist of Australian lichenicolous fungi*. (Australian Biological Resources Study: Canberra). http://www.anbg.gov.au/abrs/lichenlist/Lichenicolous_Fungi.html [Version 23 October 2012].

McCarthy, P.M. (2015). *Checklist of the lichens of Australia and its island territories.* (Australian Biological Resources Study: Canberra). http://www.anbg.gov.au/abrs/lichenlist/introduction.html [Version 2 April 2015].

Sundin, R. & Tehler, A. (1998). Phylogenetic studies of the genus *Arthonia*. *Lichenologist* 30: 381–413.

Tibell, L. (1981). Comments on Caliciales exsiccatae II. *Lichenologist* 13: 51–64.

Tibell, L. (1999). *Chaenothecopsis*. *Nordic Lichen Flora* 1: 40–49.

Triebel, D. (1989). Lecideicole Ascomyceten. Eine Revision der obligat lichenicolen Ascomyceten auf lecideoiden Flechten. *Bibliotheca Lichenologica* 35: 1–278.

Wedin, M. (1993). *Arthonia pseudocyphellariae*, a new lichenicolous fungus from the Southern Hemisphere. *Lichenologist* 25: 301–303.

Wedin, M., Baloch, E. & Grube, M. (2002). Parsimony analyses of mtSSU and nITS rDNA sequences reveal the natural relationships of the lichen families Physciaceae and Caliciaceae. *Taxon* 51: 655–660.

Wedin, M. & Hafellner, J. (1998). Lichenicolous species of *Arthonia* on Lobariaceae, with notes on excluded taxa. *Lichenologist* 30: 59–91.

Willey, H. (1890). *Synopsis of the genus Arthonia*. (E. Anthony & Sons: New Bedford, MA).

*Journal of the Adelaide Botanic Gardens* 29 (2015) 7–10



# *Hemigenia yalgensis*, a new species from the Mid-west region of Western Australia (Lamiaceae: Westringieae)

*Greg R. Guerin*

The Environment Institute, School of Biological Sciences, The University of Adelaide,
North Terrace, Adelaide, South Australia 5005
*Email*: greg.guerin@adelaide.edu.au

## Abstract

*Hemigenia yalgensis* G.R.Guerin is described from the Mid-west region of Western Australia. The species is morphologically similar to *H. macphersonii* Luehm. and under the current classification of *Hemigenia*, is placed in section *Homalochilus*. *Hemigenia yalgensis* is not currently considered to be threatened. Reference information and typification are also provided for *H. macphersonii* along with illustration and an occurrence map for the two species.

**Keywords:** *Hemigenia*, Lamiaceae, Labiatae, Mid-west, Western Australia.

## Introduction

This paper describes a new species of *Hemigenia* R.Br. from the Mid-west region of Western Australia, *H. yalgensis*. Under the current classification, the species is placed in sect. *Homalochilus* Benth., based on whorled leaves and a strongly zygomorphic calyx with reduced lobes (Guerin 2008). A key to species in this section, including undescribed species (as phrase names), was presented in Guerin (2013) and a description and illustration of corolla and stamen morphology was given in Guerin (2005). *Hemigenia yalgensis* has been recognised as a separate entity from the morphologically similar species *H. macphersonii* Luehm. (Luehmann 1898) since 1998, but was formerly undescribed. The main purpose of formally describing the species is to provide more detailed comparative information for identification than is currently available.

Herbarium voucher specimens were examined from the herbaria: AD, CANB, MEL, NSW and PERTH. Dried material was measured by hand or under light microscope. Reference information and material was compiled and compared for *Hemigenia macphersonii*, morphologically the most similar species to *H. yalgensis*.

## Taxonomy

**1. *Hemigenia yalgensis* G.R.Guerin, *sp. nov.***

**Holotypus:** 2.5 miles north of Fields Find on Yalgoo Road, W.A., *B.H.Smith 429*, 12 Sep. 1984 (PERTH 03672891). **Isotypi:** AD 98827078, CBG 8905217 at CANB, MEL 1527978.

*Hemigenia macphersonii* auct. non Luehm.: Beard, Descr. Cat. W. Austral. Pl. 93 (s.dat. [1965]), partly; J.W.Green, Cens. Vasc. Pl. W. Austral. 91 (1981), partly; B.J.Grieve, W. Austral. Wildfl., ed. 2, 3B: 447 (1981), partly; J.W. Green, Cens. Vasc. Pl. W. Austral. ed. 2, 146 (1985), partly.

*Hemigenia* sp. Yuna (*A.C.Burns 95*) Western Australian Herbarium in FloraBase http://florabase.dec.wa.gov.au [accessed: 5 August 2015]; G.Paczkowska & A.R.Chapman, W. Austral. Fl. Descr. Cat. 273 (2000).

Open, spindly *shrubs* 0.4–3 m high; *branches* glabrous except for short pubescence restricted to the leaf bases, somewhat angular to rounded in cross-section. *Leaves* 24–68 mm long, 0.5–0.8 (–2 when unfolded) mm wide, 3-whorled, sessile, erect to patent, straight or recurved, most prominently towards the apex, glabrous; lamina conduplicate but sometimes opening a little, narrowly linear; base straight; apex tapering to an acute point. *Inflorescence* a raceme-like thyrse with single flowers subtended by leaf-like bracts. *Pedicels* 2–3 mm long, pubescent, sparsely glandular or glabrous, usually with hairs becoming denser and longer distally; *bracteole pairs* 2 mm long (shorter than the calyx tube), deciduous, inserted at the mid-point of the pedicel, erect, linear and conduplicate (or partly opening), apex acute. *Calyx* (5–) 6.5–9 mm long, usually densely covered with multicellular hairs to 2.5 mm long concentrated towards the base, ± short stalked glands but sometimes glabrous, calyx lobes sparsely ciliate, glandular or glabrous, the inner surface sparsely glandular-pubescent, somewhat lengthening and becoming papery (but persistent) at fruiting stage; *tube* 3–3.5 mm long, obtriangular to funnel-shaped, with ribs which become more distinct in fruit; adaxial and abaxial lips deeply divided; *abaxial lip* 2–3.5 mm long, 2–2.8 mm wide, elliptic to suborbicular, with 2 narrowly triangular, acute lobes c. 0.8 mm long, 0.5–0.9 times the length of the adaxial lip; *adaxial lip* 3.5–6 mm long, c. 3.5 mm wide, widely ovate, and with the 2 lateral lobes distinct from, but

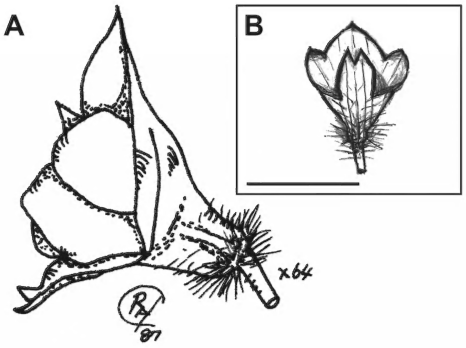


**Fig. 1.** Sketches of ***Hemigenia yalgensis***: **A** Posture of calyx and unopened corolla showing distinctive tuft of long multicellular hairs (scanned from sketch by A.L. Payne stored as part of *A.L.Payne 412*, PERTH 03672816). **B** Inset: Pressed post-flowering calyx seen from abaxial side, showing shape and relative length of the lip based on *A.C.Burns 38* (PERTH 03722449). — Scale bar: **B** 8 mm.

much smaller than, the median lobe (rarely the lateral lobes barely distinguished), the lobe apices apiculate or obtuse to rounded. *Corolla* 10–13 mm long, with tube 6–7 mm long, variable in colour, recorded as green and yellow, white tinged pink, or white with purple veins or brown/pink spots on the lower lip and throat or mauve to purple, the exterior surface pubescent, the interior surface densely bearded between the filaments; *abaxial median lobe* 4–4.8 mm long, 5.2–6 mm wide, widely elliptic, sinus 1 mm long; *lateral lobes* 3.1–4 mm long, 2.5–2.8 mm wide, oblong–obovate, apex rounded; *adaxial median lobe pair* 2.5–5 mm long, 3–5.6 mm wide, oblate, sinus 1 mm long, apex rounded. *Androecium* with the *abaxial stamens* inserted 4–5 mm from the base of the corolla, filaments 2.5–4 mm long, anthers 2 mm long, upper (adaxial) theca 0.6 mm long, lower (abaxial) theca smaller; *adaxial stamens* inserted 3–4 mm from the base of the corolla, filaments 1.5–2.5 mm long, anthers 2 mm long, fertile (adaxial) theca 0.7 mm long, the lower (abaxial) end sterile and shortly bearded. *Style* c. 7–8 mm long. *Mericarps* 2 mm long, obconic to obovoid but somewhat angular, flattened apex shallowly reticulate, distal portion glandular-pubescent, attachment scar slightly more that half the length of the mericarp. **Fig. 1, 3B.**

*Diagnostic features. Hemigenia yalgensis* is distinguished by long, narrowly linear leaves, corolla tube not (or barely) exceeding the calyx lobes and the calyx, which is deeply 2-lipped but 5-lobed. The abaxial lip of the calyx is usually half or more the length of the adaxial lip.

*Phenology.* Flowering is recorded between August and October.

*Distribution and habitat*. Occurs in the Mid-west region of Western Australia in the Geraldton Sandplains (GS),

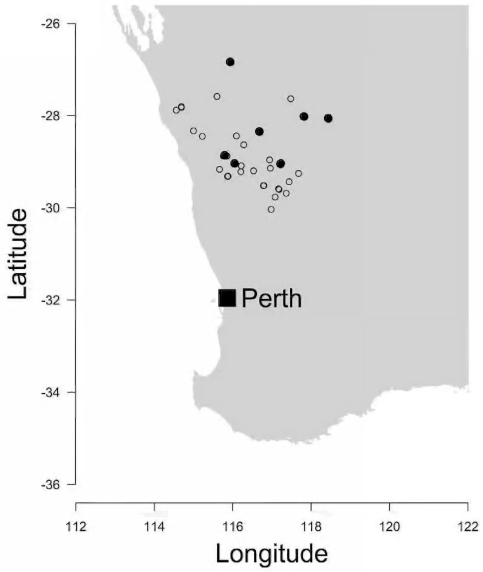


**Fig. 2.** Distribution of ***Hemigenia yalgensis*** (open circles) and ***H. macphersonii*** (closed circles) in Western Australia based on herbarium collections held at the Western Australian Herbarium (WAHERB records).

Yalgoo (YAL), Avon Wheatbelt (AW) and Murchison (MUR) IBRA bioregions. Recorded on a range of substrates including banded iron hills, granite, red loam and stony ground in low open woodland and shrubland with *Callitris*, *Eucalyptus*, *Eremophila, Acacia*, *Melaleuca, Dodonaea* and *Allocasuarina* (Fig. 2).

*Conservation status. Hemigenia yalgensis* is relatively widespread and well collected. It is not currently considered threatened.

*Etymology*. Named for the Yalgoo IBRA bioregion (and locality), around which the distribution of *H. yalgensis* is centred.

*Affinities. Hemigenia yalgensis* shares a similar geographic distribution as well as many characters with *H. macphersonii* Luehm. *Hemigenia yalgensis* has a shorter corolla, 10–13 mm long, with a tube which is not (or is barely) exserted from the calyx lobes (vs *H. macphersonii* corolla c. 20–25 mm long with tube significantly exserted from calyx lobes). The flowering calyx of *H. yalgensis* has an abaxial lip at least half the length of the adaxial lip, whereas *H. macphersonii* usually has an abaxial lip less than half the length of the adaxial lip. Post-flowering specimens can be difficult to identify, since the calyx abaxial:adaxial lip length ratio of both species can be near 0.5 and because the adaxial lip increases in length in fruiting stage (Fig. 3).

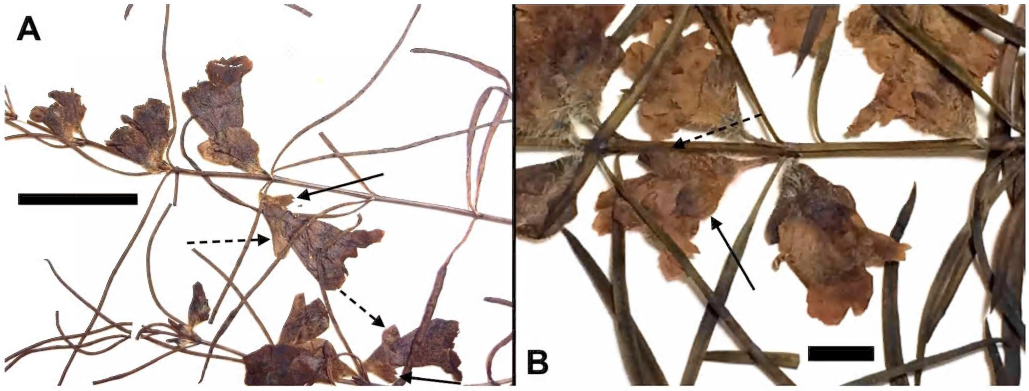


**Fig. 3.** Images of holotype specimens showing differences in floral morphology: **A *H. macphersonii***, showing larger corolla with tube long-exserted and abaxial calyx lip (solid arrows) less than half the length of the adaxial lip (dashed arrows) (MEL 646408); **B *H. yalgensis***, showing shorter corolla with tube not significantly exserted beyond calyx and abaxial calyx lip (solid arrow) more than half the length of the adaxial lip (dashed arrow) (PERTH 03672891). — Scale bars: **A** 25 mm; **B** 5 mm.

*Selected other specimens examined:*

Western Australia. c. 150 km east of Geraldton on the Yalgoo Road, *A.M.Ashby 2573*, 1 Sep. 1968 (AD 97109348); Murchison River Bridge, No. 1 Highway. The west road first turn left going north just over the bridge, *A.C.Burns 38*, 4 Sep. 1984 (PERTH 03722449); East Yuna Reserve, NE of Geraldton, *A.C.Burns 95*, 4 Oct. 1967 (PERTH 03672751); Mt Campbell, *R.Cranfield & P.Spencer 7856*, 25 Sep. 1990 (PERTH 01180428, CBG 9103634 at CANB, MEL 1603505); Mt Campbell repeater station on the Carnamah-Morawa Road, *L.A.Craven 7009*, 1 Oct. 1981 (MEL 302563, AD 98925185, PERTH 03672905, CANB 379607); Lakeside Stn I527, *A.L.Payne 412*, 13 Aug. 1987 (PERTH 03672816); Wanarra Station, *A.L.Payne 3864*, 28 Aug. 1993 (PERTH 04446356); 7.5 km N of Murchison Shire Office, *P.G.Wilson 1175 & R.Rowe*, 20 Sep. 1991 (PERTH 02116413, NSW 249958, AD 9220157).

**2. *Hemigenia macphersonii*** Luehm.

Victorian Naturalist 15: 20 (1898), as '*macphersoni*'; W.E. Blackall & B.J.Grieve, W. Austral. Wildfl. 3: 589 (1965); Beard, Descr. Cat. W. Austral. Pl.: 93 (s.dat. [1965]), partly; W.E.Blackall & B.J.Grieve, W. Austral. Wildfl., ed. 2, 3B: 447 (1981), partly; Paczk. & A.R.Chapman, West. Austral. Fl.: Descr. Cat. 272 (2000). — **Holotype:** Near Mount Magnet, Western Australia, *W.S.Macpherson s.n.*, Sep. 1897 (MEL 646408!). **Isotypes:** NSW 217075, NSW 498245.

*Hemigenia macphersonii* Diels in Diels & Pritzel, Bot. Jahrb. Syst. 35(2): 528 & 527, Fig. 59M–R (Dec. 1904), as '*macphersoni*', nom. illeg. (homonym). Bot Jahrb. Syst. 35(4): 652 (Apr. 1905), ad not. — **Type citation:** "Hab. in distr. Austin pr. Mount Margaret (leg. Macpherson)". **Holotype:** B, presumably destroyed.

*Distribution and habitat.* Occurs in the Mid-west region of Western Australia in the Avon Wheatbelt (AW), Yalgoo (YAL) and Murchison (MUR) IBRA bioregions. Recorded on various substrates including red/brown loam, clay, granite, sandstone and gravel, sometimes in association with banded ironstone formation (Meissner & Caruso 2008), often along water-courses, in *Acacia* scrub and tall shrubland (Fig. 2).

*Conservation status*. *Hemigenia macphersonii* is poorly collected but not currently considered threatened, despite being recognised as distinct from *H. yalgensis* since 1998.

*Note.* Diels described *H. macphersonii* in 1904 from a specimen cited as coming from "Mount Margaret". However, it seems that this is a mis-reading of "Mt Magnet", as all other specimens at MEL collected by W.S. Macpherson were collected from Mt Magnet (P. Milne, pers. comm., Oct. 2015). It is possible that Diels had a duplicate of Luehmann's type specimen available when describing his new species. The type specimen in Berlin was presumably destroyed during World War II, but from the description and illustration in Diels' publication, it is unambiguously the same as Luehmann's species. In addition, Diels noted in the index of his work, which was published several months after the description, that *H. macphersonii* had been described previously and he accepted that his new taxon was a synonym of Luehmann's species.

*Other specimens examined:*

Western Australia. 10 km N of Mount Magnet, *K.Ashby s.n.*, 20 Sep. 1996 (PERTH 04663578); 5.9 km N of Murchison Roadhouse, *R.J.Chinnock & G.S.Richmond RJC 8536*, 23 Oct. 1993 (AD 99350007, PERTH 05481155); Prope Yalgoo, *C.A.Gardner s.n.*, Aug. 1960 (PERTH 03672778).

## Acknowledgements

The State Herbarium of South Australia (AD) provided support and resources for this work. Loans were provided by PERTH, MEL, NSW, CANB. Barbara L. Rye originally determined specimens as *Hemigenia* sp. Yuna in 1998. Pina Milne (MEL) is thanked for checking Macpherson specimens.

## References

Guerin, G.R. (2005). Floral biology of *Hemigenia* R.Br. and *Microcorys* R.Br. (Lamiaceae). *Australian Journal of Botany* 53: 147–162.

Guerin, G.R. (2008). A taxonomic revision of *Hemigenia* section *Malleantha* sect. nov. (Lamiaceae: Westringieae). *Australian Systematic Botany* 21: 326–374.

Guerin, G.R. (2013). Distinguishing characters of *Hemigenia rigida*, a conservation significant species confused with *H. pritzelii* (Lamiaceae: Westringieae). *Nuytsia* 23: 467–474.

Luehmann, J.G. (1898). Description of a new Australian Labiatae plant. *Victorian Naturalist* 15: 20.

Meissner, R. & Caruso, Y. (2008). Flora and vegetation of banded iron formations of the Yilgarn Craton: Mount Gibson and surrounding area. *Conservation Science Western Australia* 7(1): 105–120.

*Journal of the Adelaide Botanic Gardens* 29 (2015) 11–14


# Notes on *Hibbertia* (Dilleniaceae) 11. *Hibbertia spanantha*, a new species from the central coast of New South Wales

*H.R. Toelken*[a] *& A.F. Robinson*[b]

[a] State Herbarium of South Australia, P.O. Box 2732, Kent Town, South Australia 5071
*E-mail*: hellmut.toelken@sa.gov.au

[b] Ku-ring-gai Council, 5 Suakin St., Pymble, New South Wales 2073
*E-mail*: arobinson@kmc.nsw.gov.au

## Abstract

The species *Hibbertia* sp. Turramurra (*A.F.Robinson s.n. NSW981514*), discovered in 2007 and based on a few plants in South Turramurra bushland reserve, is described as *Hibbertia spanantha* Toelken & A.F.Rob. Since its discovery it has also been found at two additional localities nearby, but it is still considered a critically endangered species.

**Keywords:** Dilleniaceae, *Hibbertia*, Sydney area, taxonomy, new species.

## Introduction

Plants of the vicinity of Sydney have been collected and studied for more than two hundred years. Finding, therefore, a species new to science is unusual, particularly in the genus *Hibbertia*, as Toelken & Miller (2012) had already described several new hibbertias from the area. The new species described here, *H. spanantha*, was first discovered in South Turramurra in 2007, the first herbarium specimens date from 2012. Extreme concern was expressed, when initially, only nine plants could be found, and in addition the vegetation around them was senescing. Two more localities, each with a few plants, were discovered nearby at Macquarie Park and Beecroft more recently.

*Hibbertia spanantha* resembles most closely species of the *H. strigosa* group (cf. Toelken & Miller 2012, p. 93) in characters, such as similar simple to sparsely fascicled or usually forked hairs, distinct intrapetiolar tufts, sessile flowers, each having more than 10 stamens with slender subequal anthers. It differs, however, from *H. strigosa* (Toelken & Miller 2012) and from most species belonging to this group, by its decumbent habit and smaller leaves, as well as specifically by its anthers being 1.4–1.6 mm long (2.1–2.4 mm long in *H. strigosa*).

***Hibbertia spanantha* Toelken & A.F.Rob., *sp. nov.***

**Typus**: New South Wales, South Turramurra, *A.F. Robinson s.n.*, ix.2012 (holo.: AD 265532; iso.: NSW 981514). [Detailed locality withheld].

*Hibbertia* sp. Turramurra (*A.F.Robinson s.n. NSW981514*) NSW Herbarium

Shrublets up to 30 cm high, diffusely decumbent to sprawling with moderately branched main branches; branches wiry-woody, with long decurrent leaf bases to almost flanged, finely hirsute. *Vestiture* ± persistent, predominantly simple, rarely forked hairs often on a tubercle particularly on leaves; *on branches* moderate to dense particularly along the groove to both sides of the decurrent leaf bases and then often forked or rarely fascicled, with mainly long fine simple hairs (1.4–1.8 mm long), antrorsely spreading and few shorter ones interspersed, without obvious tubercles; *on leaves above* scattered, with antrorse to usually erect, mainly longer simple hairs on raised tubercles, which remain when the hairs soon wear off; *on leaves below* sparse, with similar simple hairs as above but usually with less pronounced tubercles and with longer hairs mainly on the flanks of the recurved margins and the central vein, while the sparsely exposed undersurface has few short hairs towards the margins; *on bracts* like on leaves but often shorter; *on outer calyx lobes* outside sparse, with longer over shorter antrorse simple hairs without tubercles, inside largely glabrous except for appressed long and short hairs on the upper third; *on inner calyx lobes* outside sparse, with scattered smaller appressed simple hairs under longer ones mainly towards the margins, inside glabrous. *Leaves* with axillary tuft of hairs up to 1.8 mm long and continued along the grooves on both sides of the decurrent leaf bases; *petiole* 0.2–0.5 mm long; *lamina* linear to linear-oblanceolate, (2.8–) 4–7.5 (–8.6) × 0.6–0.9 mm, sparsely constricted into short petiole, obtuse to rounded with recurved apex with short hairs, above flat to convex with central vein not visible, sparsely pilose when young becoming tuberculate later, below with undersurface sometimes visible between the scarcely raised central vein and revolute margins, sparsely pilose and rarely tuberculate.

**Fig. 1.** Decumbent plant of ***Hibbertia spanantha*** in natural habitat. (Photo: A.F. Robinson).

**Fig. 2.** Close-up of flower of ***Hibbertia spanantha***. (Photo: A.F. Robinson).

*Flowers* with rounded receptacle base, sessile, terminal on all branches; *buds* ovoid-obloid; *bracts* subtending calyx, linear, 4.6–5.3 × 0.7–0.8 mm, fleshy and leaf-like, sparsely hirsute, merging into leaves. *Calyx* lobes unequal; *outer calyx lobes* lanceolate, rarely linear-lanceolate, (5.5–) 5.8–6.6 × 1.9–2.6 mm, acute with recurved apex, with revolute margins and with central ridge becoming prominent on the upper half, outside pubescent, inside pubescent on upper third; *inner calyx lobes* obovate to broadly oblong-elliptic, (4.7–) 5.2–6 × 3.5–4.4 mm, obtuse to often slightly split, scarcely ridged, outside pubescent and with glabrous membranous margins, inside glabrous. *Petals* 6.6–8.3 mm long, obovate, ± bilobed. *Stamens* 13 (–15), on one side of the ovaries; *filaments* 1–1.2 mm long; *anthers* narrowly obloid, 1.4–1.6 mm long, with back ones sometimes slightly shorter, ± abruptly constricted above and below. *Pistils* 2; *ovaries* ovoid, each with 4 ovules, erect-hirsute to sericeous; *style* attached to apex, with style base ± hairy, erect, stigmas well above anthers. *Fruit* and *seeds* not seen. *Flowering*: mainly September–November. *Suggested vernacular name*: Julian's hibbertia. **Fig. 1–4.**

*Distribution and ecology*. The species grows on sandy to light clay soils and is currently known from the Lucas Heights and Glenorie soil landscapes on the shale/sandstone transition (Chapman & Murphy 1989). It has at present been recorded from near the suburbs of Turramurra, Macquarie Park and Beecroft (NSW: Central Coast botanical region) within Ku-ring-gai, Ryde and Hornsby Local Government Areas. All known populations occur within the Lane Cove River catchment.

The altitudinal range of *H. spanantha* is between 50 and 120 metres above sea level, and the average annual rainfall in the species' distribution range is from 1,000 to 1,400 mm.

Vegetation mapping by the Office of Environment & Heritage and Sydney Metropolitan Catchment Management Authority (OEH 2013) identifies the vegetation communities at all known populations as Coastal Enriched Sandstone Dry Forest and or Coastal Shale Sandstone Forest within the broader vegetation classes of Sydney Coastal Dry Sclerophyll Forests and Northern Hinterland Wet Sclerophyll Forests (Keith 2004). Specht et al. (1995) describes both Tall Open-Forest and Open-Forest as the structural formations currently known for *H. spanantha* with all known populations occurring under a dominant tree canopy of *Eucalyptus pilularis*, *E. resinifera*, *Corymbia gummifera* and *Angophora costata*. The open understorey which supports a less diverse layer of shrubs than surrounding coastal communities includes dominant species like *Acacia linifolia*, *A. myrtifolia*, *Banksia spinulosa*, *Bossiaea obcordata*, *Hakea sericea*, *Olearia microphylla*, *Platylobium formosum*, *Persoonia laurina* subsp. *laurina*, and *Pultenaea hispidula*. Due to the richer soils that the species is associated with, a well-developed and diverse ground layer is supported and consists of species such as *Hibbertia aspera*, *Lomandra multiflora*, *Themeda australis* and *Xanthorrhoea minor*, as well as a relatively high representation from monocot families, such as Liliaceae, Orchidaceae and Poaceae.

*Hibbertia spanantha* has been observed growing most vigorously in sites exposed to greater sunlight and with limited competition from other mid and ground story species, or in places where light penetration has been increased through natural disturbance. Shaded plants seem to have fewer and shorter stems and leaves. It is therefore likely that fire, and possibly other physical disturbances that increase light levels without impacting upon the soil profile, play a role in providing for the recruitment and long term persistence of the species. Where desirable conditions are present, individuals have been observed as covering approximately 2 metres squared.

*Conservation status*. *Hibbertia spanantha* was listed as Critically Endangered on an emergency basis under the

**Fig. 3.** Plant of ***Hibbertia spanantha*** 12 month after being burnt, regenerating with erect resprouting branches and lateral suckers. (Photo: A.F. Robinson).

**Fig. 4.** Seedlings of ***Hibbertia spanantha*** 12 month after a fire, with short, almost appressed hairs on lower leaves and long spreading ones higher up. (Photo: A.F. Robinson).

name *Hibbertia* sp. Turramurra (*A.Robinson s.n. NSW 981514*) by the N.S.W. Scientific Committee (2014), due to the low number of mature individuals. The final determination of the Committee retained the listing as Critically Endangered (N.S.W. Scientific Committee 2015). At present it is only known from three small populations with about 20 adult plants. Importantly, more than 50 seedlings have been recently observed following fire at one location. A targeted strategy for managing this species will be developed under the 'Saving our species' conservation program by the N.S.W. Office of Environment and Heritage.

*Diagnostic features*. Among *Hibbertia* species with stamens to one side of the ovaries, this species is distinguished by the combination of: decumbent habit; mixed longer and shorter fine simple hairs, which have pronounced basal tubercles particularly on the upper surface of leaves; bracts indistinguishable from the leaves; single sessile flowers borne terminally on larger branches; and, most importantly, 13–15 stamens bear slender subequal anthers (1.4–1.6 mm long) overtopping the hirsute to sericeous ovaries.

*Hibbertia spanantha* closely resembles *H. puberula*, as they have a similar habit, leaves and mainly simple hairs in common. The former is, however, distinguished by the erect hairs of the intrapetiolar tufts being continued along the decurrent grooves on the sides of the leaf bases, by the absence of hooked hairs on the calyx and, in particular, the ovaries are ovoid and hirsute to sericeous, while *H. puberula* has puberulous obloid ovaries with an almost truncate apex.

*Notes*. Little is known about the growth habits of *H. spanantha*, although a fire to part of the original population made the following observations possible: recruitment was noted approximately 3 months following a fire in summer, which achieved a moderate intensity of burning. All burnt mature individuals responded and re-established through vigorous re-sprouting via either coppicing or suckering from rootstock or both. All above ground stems were killed by the fire. Additionally, fire triggered germination from the soil stored seed bank, indicating a persistent soil seed bank. Similar responses to fire or smoke treatment to promote seed germination have variously been reported, e.g. Allen et al. (2004) and Bell et al. (1993) found resprouting of some hibbertias after fires. Consistent post fire rainfall resulting in prolonged soil moisture availability is assumed to have assisted these recruitment responses.

This suggests that fire is required to provide the right conditions for germination and seedling growth and that seedlings are not likely to establish at any time other than after fire, i.e. populations appear to be maintained by fire. This point is also supported by observations (by the second author), which indicate that seedlings or young plant recruitment has only taken place in burnt areas.

The age at which the species flowers and fruits is unknown. One population has not received fire for more than 50 years, indicating that *H. spanantha* is a long-lived species. Flowering has been observed to be infrequent, inconsistent, with relatively few flowers produced and some flowers not fully opening. Nor is it known how the species is pollinated. Little is known in relation to seed production and dispersal, although seedlings appear to have germinated in clusters, suggesting minimal seed migration from parent plants. It is also possible that ants deposited the seeds here after they had harvested the aril, for which they originally collect the diaspores, as Rice & Westoby (1981) suggested for hibbertias from nearby West Head. The extent of flowering appears to be directly related to environmental conditions, such as rainfall, as successful flowering and seed production have been evident following good post fire autumn and winter rainfall.

*Morphological variation*. The simple hairs in the grooves on either side of the decurrent leaf base are often so dense that some of them could also be determined

as forked or rarely clustered, as in fascicled hairs. The hairs on lower branches and leaves of coppice shoots (*A.F.Robinson s.n.,* as held at AD) are fewer, distinctly shorter and simple, but they become larger after the third leaf, denser (cf. Fig. 4) and especially more frequently forked. A similar development from simple to forked hairs was also observed on seedlings (*A.F.Robinson s.n.*, as held at NSW), as compared to compound hairs being reduced to simple ones in some species of the *H. hermanniifolia* group (Toelken 2012, Fig. 1).

*Etymology*. As specimens examined at present were "few-flowered", Greek "span-antha" was chosen as the epithet of this species. The vernancular name "Julian's hibbertia", was proposed in honour of Julian Poulton, who inspired the second author to pursue conservation as a career.

*Specimens examined [detailed localities withheld for conservation reasons]:*

New South Wales. **Central Coast:** *L.Jerofke s.n.*, Macquarie Park, 12.ix.2014 (NSW 859349); *R.L.Johnstone 3344 & M.Viler*, Beecroft, 29.x.2013 (NSW); *B.J.Pellow & J.Bevon s.n.*, Beecroft, 4.x.2013 (NSW 859342); *A.F.Robinson s.n.*, South Turramurra [coppicing branches], xi.2014 (AD); *A.F. Robinson s.n.*, South Turramurra [seedling], xii. 2014 (NSW 883772).

## Acknowledgements

The close cooperation with Andrew Orme (NSW), especially for sending the original material to the first author, was very much appreciated; he also communicated further information about the new species. Additionally, the support and assistance offered by Dominic Edmonds (Ku-ring-gai Council) is greatly appreciated by the second author.

## References

Allen, S.M., Adkins, S.W., Preston, C.A. & Bellairs, S.M. (2004). Improved germination of Australian natives: *Hibbertia commutata*, *Hibbertia amplexicaulis* (Dilleniaceae), *Chamaescilla corymbosa* (Liliaceae) and *Leucopogon nutans* (Epacridaceae). *Australian Journal of Botany* 52: 345–351.

Bell, T.D., Plummer, J.A. & Taylor, S.K. (1993). Seed germination ecology in south western Australia. *The Botanical Review* 59(1): 34–69.

Chapman, G.A. & Murphy, C.L. (1999). *Soil landscapes of Sydney 1:10.000 sheet*. (Soil Conservation Service of N.S.W.: Sydney).

Keith, D.A. (2004). *Ocean shores to desert dunes: the native vegetation of New South Wales and the A.C.T.* (Department of Environment and Conservation, N.S.W.: Hurstville).

N.S.W. Scientific Committee (2014). *Determination for provisional listing of a critically endangered species on an emergency basis* — Hibbertia *sp. Turramurra (*A.Robinson s.n. NSW981514*)*. (N.S.W. Scientific Committee: Hurstville). [Gazetted: 15 Aug. 2014]. www.environment.nsw.gov.au/resources/threatenedspecies/determinations/PLHibbTurr.pdf [accessed: 15 Sep. 2015].

N.S.W. Scientific Committee (2015). *Final Determination* — Hibbertia *sp. Turramurra (*A.Robinson s.n. NSW 981514*)*. (N.S.W. Scientific Committee: Hurstville). [Gazetted: 2 Oct. 2015]. http://www.environment.nsw.gov.au/resources/threatenedspecies/determinations/FDHibbTurraCR.pdf [accessed: 12 Oct. 2015].

Office of Environment and Heritage [OEH] (2013). *The native vegetation of the Sydney metopolitain area. Vol. 1: Technical report* (Ver. 2.0). (Department of Premier and Cabinet, N.S.W.: Sydney).

Rice, B.L. & Westoby, M. (1981). Myrmecochory in sclerophyll vegetation of the West Head, New South Wales. *Australian Journal of Ecology* 6: 291–298.

Specht, R.L., Specht, A., Whelan, M.B. & Hegarty, E.E. (1995). *Conservation atlas of plant communities in Australia*. (Centre for Coastal Management, Southern Cross University Press: Lismore).

Toelken, H.R. (2012). Notes on *Hibbertia* (Dilleniaceae) 7. *H. hermanniifolia* group (subgen. *Hemistemma*) from mainly temperate eastern Australia. *Journal of the Adelaide Botanic Gardens* 25: 55–70.

Toelken, H.R. & Miller, R.T. (2012). Notes on *Hibbertia* (Dilleniaceae) 8. Seven new species, a new combination and four new subspecies from the subgen. *Hemistemma*, mainly from the central coast of New South Wales. *Journal of the Adelaide Botanic Gardens* 25: 71–96.

*Journal of the Adelaide Botanic Gardens* 29 (2015) 15–21


# Observations on some calcicolous species of *Lecania* A.Massal. (lichenised Ascomycetes: Ramalinaceae) in southern Australia

*Gintaras Kantvilas*[a] *& Pieter P.G. van den Boom*[b]

[a] Tasmanian Herbarium, Private Bag 4, Hobart, Tasmania 7001, Australia
*Email*: Gintaras.Kantvilas@tmag.tas.gov.au

[b] Arafura 16, 5691JA Son, The Netherlands
*Email*: pvdboom@kpnmail.nl

## Abstract

Four species of *Lecania* A.Massal. occurring on calcareous substrata in southern Australia are treated. *Lecania maritima* Kantvilas & van den Boom is described as new to science and is recorded from Kangaroo Island and Flinders Island. *Lecania polycarpa* (Müll.Arg.) Kantvilas & van den Boom, comb. nov., is an Australian endemic, known from Kangaroo Island, Flinders Island and the Victorian coast. Two further species are widely distributed, chiefly in temperate areas of the world: *L. inundata* (Hepp ex Körb.) M.Mayrhofer and *L. turicensis* (Hepp) Müll.Arg. are both reported for Tasmania for the first time; the former is also a new record for Victoria. The salient features of these four taxa are compared.

**Keywords:** biodiversity, *Catillaria*, lichens, new taxa, Kangaroo Island, Tasmania, Victoria.

## Introduction

This paper continues the investigation of the lichens of Kangaroo Island in anticipation of a checklist for the island; earlier contributions to this project include Elix & Kantvilas (2013a, b), Kantvilas & Elix (2014), Kantvilas & Kondratyuk (2013), Kantvilas & van den Boom (2013), Kantvilas & Wedin (2015) and McCarthy & Kantvilas (2013a, b). This paper deals with *Lecania* A.Massal., a genus of crustose lichens in the family Ramalinaceae that contains about 40 described species (Kirk et al. 2001), including eight that have been recorded for Australia (McCarthy 2015).

*Lecania* is characterised by a green, coccoid photobiont, biatorine to lecanorine apothecia, *Bacidia*-type asci and hyaline, non-halonate, ± ellipsoid, trans-septate ascospores. Identification and delimitation of species of *Lecania* is generally regarded as difficult (Fletcher et al. 2009), especially due to highly variable attributes of the thallus and apothecial margin. As a result of this last feature in particular, species can be confused with the unrelated genus *Catillaria* A.Massal., which shares with *Lecania* 1-septate, hyaline ascospores, but has different excipular and hymenial anatomy, including markedly different asci (*Catillaria*-type; Hafellner 1984). There are several regional, Northern Hemisphere treatments of the genus (e.g. Mayrhofer 1988, Fletcher et al. 2009, van den Boom & Ryan 2004) that greatly assist in the identification of Australian collections. A synopsis of the species recorded for Australia has also been published (van den Boom & Mayrhofer 2007).

Species of *Lecania* are found mostly in temperate to subtropical latitudes and occur on a wide range of substrata, including rocks, bark, wood, soil, shell or bone fragments, and man-made materials such as concrete. Four calcicolous, Australian taxa are documented in the present study.

## Methods

The study is based chiefly on collections of the first author, housed in the Tasmanian Herbarium (HO) with duplicates distributed to the State Herbarium of South Australia (AD), the Australian National Herbarium (CANB), herb. van den Boom (Netherlands) and elsewhere, and on comparison with herbarium material from the Northern Hemisphere. The descriptions are based exclusively on the Australian material studied, and significant deviations from existing descriptions (essentially from Northern Hemisphere studies) are highlighted. Hand-cut sections of the thallus and ascomata were mounted in water, 15% KOH (K), Lugols Iodine after pretreatment with K (IKI), ammoniacal erythrosin and 50% $HNO_3$ (N) for examination by high-power light microscopy. Dimensions of asci and ascospores are based on 20 and at least 50 observations respectively. The latter are presented in the format: 5$^{th}$ percentile–*average*–95$^{th}$ percentile; outlying extreme values are given in parentheses. Nomenclature of asci follows Hafellner (1984); that of pigments follows Meyer & Printzen (2000).

## Taxonomy

### 1. *Lecania inundata* (Hepp ex Körb.) M.Mayrhofer

Biblioth. Lichenol. 28: 66 (1988).

*Thallus* crustose, areolate, often minutely papillate,

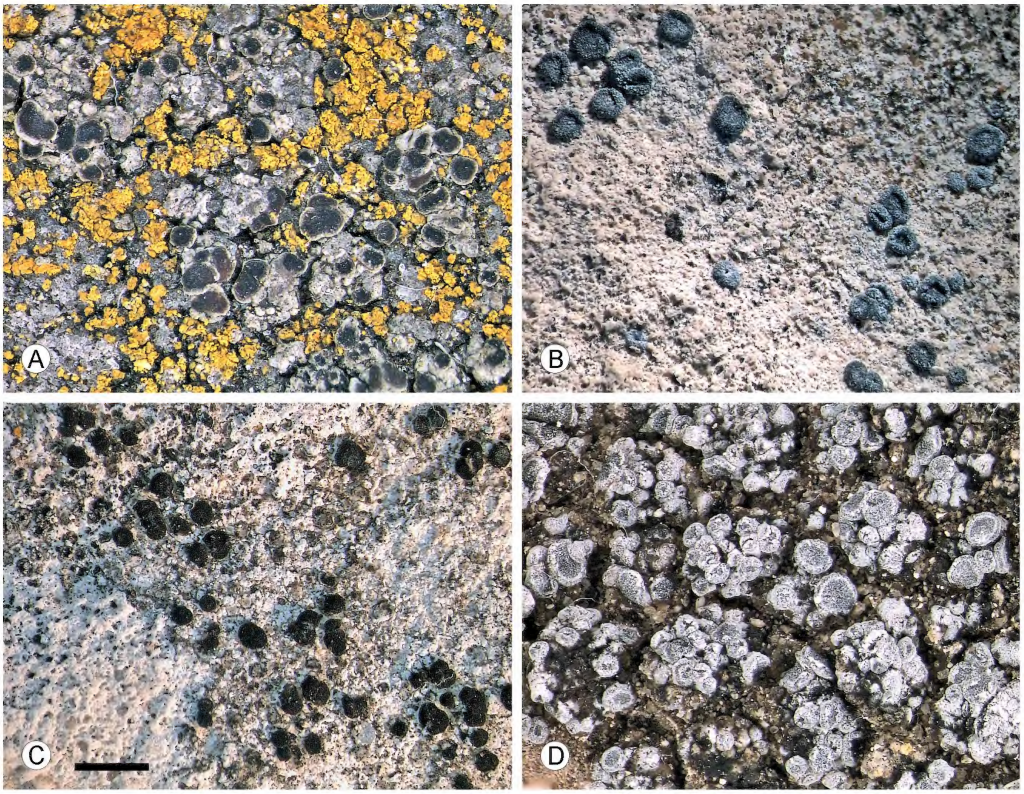


**Fig. 1.** Habit of calcicolous *Lecania* species. **A *L. inundata*** (*Kantvilas 270/13*); **B *L. maritima*** (holotype, *Kantvilas 281/13*); **C *L. polycarpa*** (*Kantvilas 307/13*); **D *L. turicensis*** (*Kantvilas 304/13*). — Scale: 1 mm.

yellowish brown to grey-brown or dark brown, epruinose, not delimited by a prothallus; individual areoles contiguous or dispersed, loosely attached to the substratum, to 0.6 mm thick, with a cortex to c. 50 µm thick, sometimes becoming granular, rarely very sparse and the thallus then dominated by apothecia; photobiont cells broadly ellipsoid to ± globose, 7–23 × 5–20 µm. *Apothecia* lecanorine, superficial, basally constricted, to 0.8 mm diam., typically very numerous, scattered or crowded together and ± obscuring the thallus; disc pale brown, orange-brown to dark brown, sometimes mottled, rarely grey-pruinose, plane at first, soon becoming convex; thalline excipulum pale grey to pale grey-brown, entire, crenulate or radially fissured, epruinose, becoming inapparent and excluded in more convex apothecia, in section (40–) 70–100 µm thick, cupular, densely packed with photobiont cells, usually with a hyaline outer layer 10–20 µm thick, becoming reflexed in more convex apothecia. *Hypothecium* 50–80 µm thick, hyaline to pale yellowish, not inspersed. *Hymenium* 55–70 µm thick, hyaline, not inspersed, overlain with an orange-brown to purple-brown epihymenial layer to 10–20 µm thick, K–, N± orange-brown. *Asci* 8-spored, 40–50 × 12–15 µm, clavate, of the *Bacidia*-type, with a prominent amyloid tholus and a conical, weakly amyloid masse axiale; ocular chamber lacking or weakly developed. *Paraphyses* simple, 2.5–3 µm wide; most apices prominently enlarged to 3–7 µm, with the terminal cells coated with pigment. *Ascospores* ellipsoid, hyaline, thin-walled, non-halonate, (10–) 11–*13.6*–17 (–19) × (4–) 4.5–*5.2*–6 (–7) µm, (0–) 1-septate. *Pycnidia* not found. *Chemistry*: no substances detected by t.l.c. **Fig. 1A, 2C.**

*Remarks. Lecania inundata* is widely distributed in the Northern Hemisphere [for example, see Fletcher et al. (2009) and van den Boom & Ryan (2004), who also provide descriptions]. In Australia, van den Boom & Mayrhofer (2007) record this species for South Australia and New South Wales; it is recorded here for Tasmania and Victoria for the first time. It is characterised by a pale greyish or brownish, areolate, rather nodular, epruinose thallus with minute papillae, and by the usually clustered, epruinose apothecia that are initially lecanorine but at length become strongly convex and with an excluded margin. The individual papillae are

**Table 1.** Comparison of salient features of calcicolous ***Lecania*** species.

| | *L. inundata* | *L. maritima* | *L. polycarpa* | *L. turicensis* |
|---|---|---|---|---|
| **thallus** | areolate, minutely papillate, yellowish brown to grey-brown, epruinose | endolithic, inapparent | endolithic, inapparent | granular-areolate, grey to brown, pruinose |
| **apothecia** | lecanorine, to 0.8 mm diam. | biatorine, to 0.8 mm diam. | biatorine, to 0.6 mm diam. | lecanorine, to 1 mm diam. |
| **apothecial margin** | pale greyish, epruinose, 40–100 µm thick, becoming excluded | black, pruinose, 50–80 µm thick, opaque in section, persistent | black, mostly epruinose, 30–80 µm thick, translucent in section, becoming excluded | grey-brown, pruinose, 70–100 µm thick, persistent or becoming excluded |
| **apothecial disc** | pale to dark brown, rarely pruinose | black, pruinose | black to brown-black, mostly epruinose | red-brown to dark brown, pruinose |
| **ascospores** | 10–19 × 4–7 µm, (0–) 1-septate | 10–16 × 4.5–6 µm, (0–) 1-septate | 10–15 × 4–6 µm, (0–) 1-septate | 10–20 × 4–6 µm, (0–) 1-septate |

larger than blastidia, have a smooth upper surface and well-developed, algal-free zone that can in part be transformed into a layer of dead cells (Mayrhofer 1988). There are several related or at least superficially similar species with which it can be confused, as discussed by Fletcher et al. (2009) and van den Boom & Ryan (2004) in their accounts of the genus in Britain and North America, respectively. Of these, two have been recorded for Australia (van den Boom & Mayrhofer 2007): *L. erysibe* (Ach.) Mudd, which differs from *L. inundata* by its blastidiate thallus, and *L. rabenhorstii* (Hepp) Arnold, which has a thallus of smooth areoles. When poorly developed, these three taxa can be difficult to distinguish. Salient features that distinguish *L. inundata* from the other species studied are summarised in Table1.

*Lecania inundata* grows on naturally-occurring or man-made calcareous substrata including concrete, mortar and asbestos tiles, as well as on more acidic rocks in nutrient-enriched habitats. Some of the specimens studied here (*Kantvilas 270/13, 333/13*) are from coastal sites affected by eutrophication from birds. Others are from old concrete in urban areas (*Kantvilas 161/98*, *Stajsic 6203*). The species with which the specimens studied were associated included typical calciphiles or nitrophiles, including *Buellia albula* (Nyl.) Müll.Arg., *Caloplaca cranfieldii* S.Y.Kondr. & Kärnefelt, *C. mereschkowskiana* S.Y.Kondr. & Kärnefelt, *Candelariella aurella* (Hoffm.) Zahlbr., *Lecanora dispersa* (Pers.) Sommerf., *Physcia adscendens* (Fr.) H.Olivier, *Rinodina williamsii* H.Mayrhofer and *Xanthoria ligulata* (Körb.) P.James. Although the type collection of this species comes from inundated granite blocks along the Neckar River (Germany), *L. inundata* is predominantly a species of drier habitats.

*Specimens examined:*

South Australia. **Kangaroo Island:** northern end of Antechamber Bay, 35°46'S 138°04'E, 5 m alt., 22 Sep. 2013, *G. Kantvilas 270/13* (herb. v.d. Boom, HO); the old Cannery, American R., c. 1 km SW of Ballast Head, 35°46'S 137°48'E, 2 m alt., 14 Sep. 2013, *G. Kantvilas 333/13 & B. de Villiers* (herb. v.d. Boom, HO).

Tasmania. Cascades, Hobart, 42°54'S 147°17'E, 130 m alt., 6 Sep. 1998, *G. Kantvilas 161/98* (herb. v.d. Boom, HO); Maria Island, Fossil Cliffs, 42°34'S 148°05'E, 5 m alt., 15 May 2000, *G. Kantvilas 189/00* (herb. v.d. Boom, HO).

Victoria. South Yarra, Royal Botanic Gardens, 37°49' 52"S 144°58'37"E, 28 June 2011, *V. Stajsic 6203* (HO, MEL).

New South Wales: Sydney, Aug. 1988, *J. MacDonald s.n.* (HO).

## 2. *Lecania maritima* Kantvilas & van den Boom, *sp. nov.*

*Thallo endolithico inconspicuoque, apotheciis pruinosis, biatorinis, excipulo proprio persistenti, in sectione opace rubro-brunneo, cellulas algarum destituto, ascis typo* Bacidiae *pertinentibus et ascosporis uniseptatis, 10–16 µm longis, 4.5–6 µm latis distinguibilis.*

**Mycobank no.:** MB814786

**Typus:** South Australia. Kangaroo Island, near Pelican Lagoon, summit of hill above the Tiger Simpson memorial, 35°50'S 137°49'E, 60 m alt., on limestone outcrops in pasture, 19 Sep. 2013, *G. Kantvilas 281/13* (holo: HO; iso: AD, herb. v.d. Boom).

*Thallus* endolithic, inapparent, undelimited, not causing any discoloration of the substratum, rarely very thin, scurfy and discontinuous, whitish and concolorous with the substratum; photobiont cells globose to ellipsoid, 7–13 × 8–18 µm. *Apothecia* biatorine, superficial, basally constricted, 0.3–0.6 (–0.8) mm diam., scattered; disc black, at first plane to concave, then plane to undulate, sometimes becoming markedly convex, mostly lightly grey-pruinose, rarely epruinose; proper excipulum concolorous with the disc, grey pruinose, inrolled and ± obscuring the disc when young, mostly remaining prominent and persistent through later stages of development, becoming obscure only in very convex apothecia, in section 50–80 µm thick, ± annular but sometimes almost continuous beneath the hymenium, entirely opaque reddish brown at the sides, somewhat paler reddish brown centrally beneath the hymenium, unchanged or somewhat purplish brown

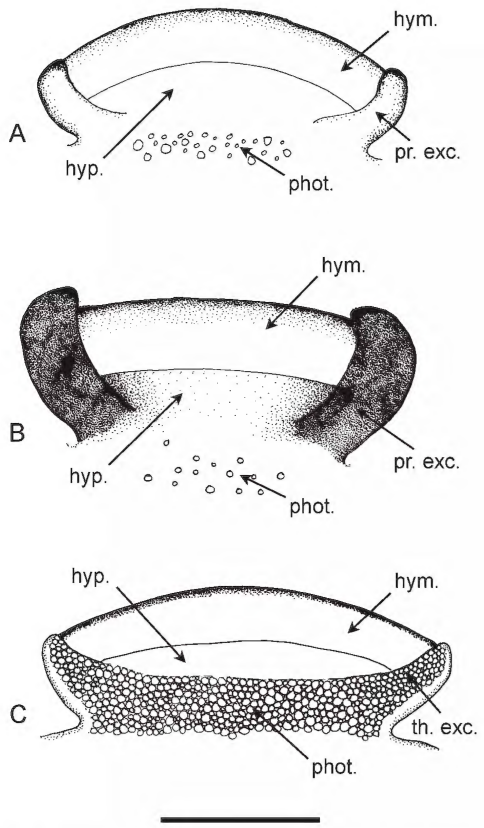


**Fig. 2**. Anatomy of the apothecia of *Lecania* species (schematic). **A** biatorine (***L. polycarpa***); **B** biatorine and heavily pigmented (***L. maritima***); **C** lecanorine (***L. inundata*** and ***L. turicensis***). — Scale: 300 µm. Abbreviations: hym.: hymenium; hyp.: hypothecium; phot.: photobiont cells; pr. exc.: proper excipulum; th. exc.: thalline excipulum.

in K, N+ orange-brown, composed of a reticulum of highly branched hyphae 2.5–3.5 µm wide, entirely lacking any photobiont cells. *Hypothecium* 20–50 µm thick, poorly differentiated, hyaline or, more often, discoloured at least in part by adjacent excipular and hymenial pigments, occasionally inspersed with scattered oil droplets. *Hymenium* 60–75 µm thick, not inspersed, coherent in water and KOH, mostly hyaline but overlain with an olive-grey epihymenial layer c. 10 thick, K–, N+ rather fleetingly crimson, the coloration often diffusing through the entire hymenium. *Asci* 8-spored, 40–55 × 10–17 µm, clavate, of the *Bacidia*-type, with a prominent amyloid tholus and a conical, weakly amyloid masse axiale; ocular chamber lacking or weakly developed. *Paraphyses* simple, 1.5–2.5 (–3) µm wide; apices prominently enlarged to 3–6 µm, with the terminal cells coated with pigment, sometimes also internally pigmented. *Ascospores* ellipsoid, hyaline, thin-walled, non-halonate, 10–*12.5*–15 (–16) × 4.5–*5.3*–6 µm, (0–) 1-septate. *Pycnidia* minute, speck-like, immersed in shallow pits in the substratum; conidia strongly curved, 10–20 × 1 µm. *Chemistry*: no substances detected by t.l.c. **Fig. 1B, 2B, 3D–F.**

*Etymology.* The specific epithet alludes to the lowland, coastal habitat of the new taxon.

*Remarks. Lecania maritima* is best characterised by the combination of an inconspicuous, endolithic thallus and biatorine, pruinose apothecia with a mostly persistent proper excipulum that is opaque red-brown in section. It bears many similarities with *L. polycarpa* (Tab. 1), which has a ± identical thallus and habit but which has an internally hyaline or only dilutely pigmented proper excipulum that becomes excluded early in development. Although overlapping in size, the conidia of *L. polycarpa* are also marginally shorter. With their persistent, prominent margin, the pruinose apothecia of *L. maritima* are also reminiscent of *L. turicensis*, but in that species the apothecial margin is clearly thalline and, when viewed in section, is packed with photobiont cells (Fig. 2C). In contrast, photobiont cells are completely absent from the excipulum of *L. maritima* (and *L. polycarpa*).

The epithecial pigments in these three species also differ. Pigments and their disposition provide a useful taxonomic character in *Lecania* (viz. Mayrhofer 1998), but they have not been formally characterised in the manner of, for example, Meyer & Printzen (2000). The epihymenium of *L. maritima* is olive-grey and reacts N+ crimson. This pigment is not the same as the greenish, N+ crimson pigments seen in *Megalaria*, *Mycoblastus* and other genera because it has no hint of green, and the N-reaction fades rather quickly. The pigment also occurs in the upper, outer edges of the excipulum. In contrast, *L. turicensis* contains a reddish brown pigment that reacts N+ orange-brown. In *L. polycarpa*, the predominant pigment is the same N+ orange-brown one as in *L. turicensis*, although traces of the olive *maritima*-pigment can be present as well, because a fleeting, patchy N+ crimson reaction can sometimes be observed in addition to the predominant N+ orange-brown.

Interpretation of the excipular and hypothecial tissues in this new taxon is somewhat equivocal. In some sections, the opaque excipular layer is continuous or almost so beneath a clearly paler, but rather thin hypothecial layer. In other sections, the central area beneath the hypothecium is a more dilute red-brown, and it can be hard to distinguish a clear boundary between excipulum and hypothecium. The key character for this species, however, namely the opaque excipulum at the sides, is unambiguous.

The new species has been recorded from coastal limestone on Kangaroo Island and Flinders Island. Specimens from the latter locality are included under *L.*

*maritima* with some reservation. They concur anatomically with the typical Kangaroo Island collections, yet their apothecia tend to be at the larger end of the range (commonly up to 0.8 mm wide, whereas KI specimens rarely exceed 0.6 mm), and epruinose apothecia with a convex disc and a reduced margin are also more common.

On Kangaroo Island, *L. maritima* is locally common on outcrops and large boulders of limestone in rough, stony pasture near the coast, whereas on Flinders Island it was recorded on outcrops in coastal heathland. The species is part of a rich calcicolous association that includes *Buellia albula*, *Caloplaca yorkensis* S.Y.Kondr. & Kärnefelt, *C. johnwhinrayi* S.Y. Kondr. & Kärnefelt, *C. kantvilasii* S.Y.Kondr. & Kärnefelt, *C. mereschkowskiana* and *Sarcogyne meridionalis* P.M.McCarthy & Kantvilas. It is common to see orange apothecia of *Caloplaca* species scattered amongst the black apothecia of the *Lecania*.

*Specimens examined:*

South Australia. **Kangaroo Island:** Stokes Bay, 35°37'S 137°13'E, 60 m alt., 29 Sep. 2013, *G. Kantvilas 302/13, 303/13 & B. de Villiers* (AD, herb. v.d. Boom, HO); Red House Bay, 35°49'S 138°06'E, 15 m alt., 17 Sep. 2013, *G. Kantvilas 310/13 p.p.* (HO); Pelican Lagoon, 35°48'S 137°48'E, 20 m alt., 27 Sep. 2012, *G. Kantvilas 414/12 & B. de Villiers* (herb. v.d. Boom, HO).

Tasmania. **Flinders Island:** The Dock, 39°48'S 147°52'E, 10 m alt., 21 Mar. 2014, *G. Kantvilas 310/14, 306/14* (herb. v.d. Boom, HO); Trousers Point, 40°13'S 148°02'E, 5 m alt., 23 Mar. 2014, *G. Kantvilas 344/14, 347/14* (CANB, herb. v.d. Boom, HO).

### 3. *Lecania polycarpa* (Müll.Arg.) Kantvilas & van den Boom, *comb. nov.*

**Mycobank no.:** MB814787

*Patellaria polycarpa* Müll.Arg., Bull. Herb. Boissier 1: 48 (1893); *Catillaria polycarpa* (Müll.Arg.) Zahlbr., Catal. Lich. Univ. 4: 63 (1926). — **Type:** Victoria: ad saxa calcarea prope Warnambool, *F.R.M. Wilson 640* (holo: G!; iso: HO!, MEL, NSW!)

*Thallus* endolithic, inapparent, undelimited, not causing any discoloration of the substratum; photobiont cells globose to ellipsoid, 7–17 × 6–15 µm. *Apothecia* biatorine, superficial, basally constricted, 0.2–0.6 mm diam., typically very abundant and ± evenly scattered; disc black to brown-black, more rarely brown or piebald when in shade, plane to convex, often very markedly so, epruinose or with a light, rather discontinuous grey pruina; proper excipulum concolorous with the disc, inrolled and crenulate when young but soon becoming inconspicuous and excluded, sometimes pruinose in very young apothecia, in section 30–80 µm thick, annular, brown to reddish brown at the outer edge, colourless or very dilute brownish within, composed of a reticulum of highly branched hyphae 2.5–4 µm wide, entirely lacking any photobiont cells. *Hypothecium* 50–100 µm thick, mostly hyaline or very pale yellowish, occasionally inspersed with scattered oil droplets, poorly differentiated from the subapothecial medulla. *Hymenium* 55–70 µm thick, hyaline, not inspersed, highly coherent in water and KOH, overlain with a brown to reddish brown epihymenial layer to 10–15 µm thick consisting of the uppermost, pigmented cells of the paraphyses, K– or ± intensifying purplish brown, N+ orange-brown or crimson-orange. *Asci* 8-spored, 40–50 × 11–15 µm, clavate, of the *Bacidia*-type, with a prominent amyloid tholus and a conical, weakly amyloid masse axiale; ocular chamber lacking or weakly developed. *Paraphyses* simple, 1.2–2.5 µm wide; apices prominently enlarged to 3–7 µm wide, with the terminal cells coated with pigment as well as internally pigmented. *Ascospores* ellipsoid, hyaline, thin-walled, non-halonate, 10–*12.3*–14.5 (–15) × 4–*4.9*–5.5 (–6) µm, (0–) 1-septate. *Pycnidia* immersed, minute, speck-like, uncommon; conidia strongly curved, 10–12 × 1 µm. *Chemistry*: no substances detected by t.l.c. **Fig. 1C, 2A, 3A–C.**

*Remarks.* This species is characterised by the numerous black scattered apothecia, at most with a sparse, discontinuous grey pruina, which stand out starkly against the white limestone substratum, the complete lack of any detectable thallus, and, anatomically, by the complete absence of photobiont cells in the apothecial margin (Tab. 1). It is probably best compared to the European *L. sylvestris* (Arnold) Arnold, which was recorded for Australia (W.A.) by van den Boom & Mayrhofer (2007), but which differs by having paler, orange to dark brown apothecial discs and an apothecial margin that contains photobiont cells at the base (Fletcher et al. 2009).

*Lecania polycarpa* occurs on rather dry, exposed, relatively soft limestone rocks in lowland and coastal areas. Associated species include *Buellia albula*, *Caloplaca yorkensis*, *Placynthium* cf. *nigrum* (Huds.) S.F.Gray and *Sarcogyne meridionalis*. It has been recorded from Victoria (the type), Kangaroo Island and Flinders Island. On Kangaroo Island, it is particularly common on limestone boulders and outcrops in roughly cleared pasture, whereas on Flinders Island it is common on coastal calcarenite. Both habitat types are common across southern Australia, suggesting that this species is likely to be more widely distributed.

*Specimens examined:*

South Australia. **Kangaroo Island:** Red House Bay, 35°49'S 138°06'E, 15 m alt., 17 Sep. 2013, *G. Kantvilas 307/13* (AD, herb. v.d. Boom, HO); near Pelican Lagoon, 35°50'S 137°49'E, 60 m alt., 19 Sep. 2013, *G. Kantvilas 285/13* (herb. v.d. Boom, HO); Point Ellen, 36°00'S 137°11'E, 5 m alt., 26 Sep. 2013, *G. Kantvilas 215/13* (HO).

Tasmania. **Flinders Island:** The Dock, 39°48'S 147°52'E, 10 m alt., 21 Mar. 2014, *G. Kantvilas 304/14, 305/14* (CANB, herb. v.d. Boom, HO); Cave Beach, 40°01'S 147°53'E, 2 m alt., 23 Mar. 2014, *G. Kantvilas 233/14* (HO); Trousers Point, 40°13'S 148°02'E, 5 m alt., 23 Mar. 2014, *G. Kantvilas 361/14* (CANB, HO).

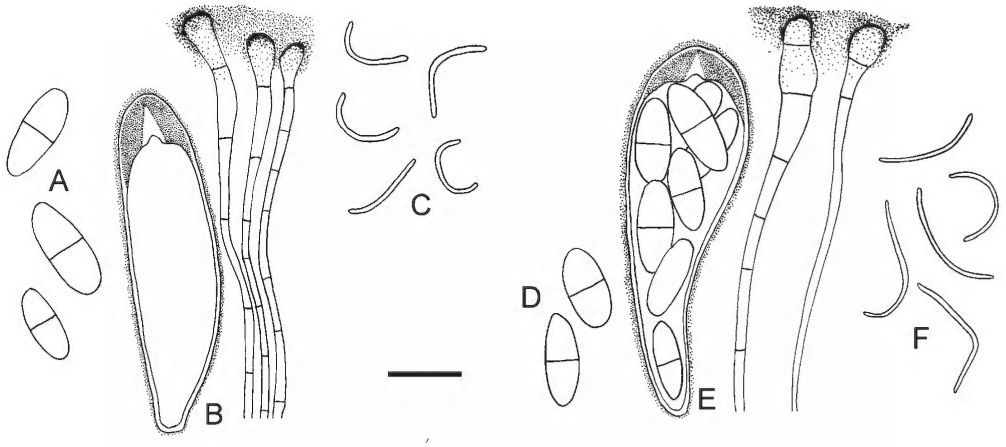


**Fig. 3.** Ascospores, asci (with amyloid parts stippled), paraphyses and conidia of *Lecania* species. **A–C *L. polycarpa*** (isotype, *F.R.M. Wilson 640*, HO); **D–F *L. maritima*** (holotype, *G. Kantvilas 281/13*). — Scale: 20 µm.

**4. *Lecania turicensis* (Hepp) Müll.Arg.**

Mém. Soc. Phys. Hist. Nat. Genève 16: 386 (1862).

*Thallus* crustose, granular-areolate, often rather gnarled, grey to dull brown, frequently pale grey-pruinose entirely or in patches, undelimited; individual areoles contiguous or dispersed and separated by deep cracks, loosely attached to the substratum, to 0.6 mm thick, with a cortex c. 15–20 µm thick; photobiont cells globose to ellipsoid or oblong, 6–20 × 5–17 µm. *Apothecia* lecanorine, superficial, basally constricted, 0.3–1 mm diam., typically numerous, crowded together and rather mis-shapen; disc red-brown to dark brown to blackish, commonly grey-pruinose, plane at first, soon becoming undulate to convex; thalline excipulum initially prominent and entire, often grey-pruinose, becoming inapparent and excluded in more convex apothecia, in section 70–100 µm thick, cupular, densely packed with photobiont cells, with a hyaline or reddish brown outer layer, 15–20 µm thick. *Hypothecium* 50–100 µm thick, hyaline, inspersed with scattered oil droplets. *Hymenium* (50–) 55–75 µm thick, hyaline, not inspersed, overlain with a reddish brown epihymenial layer to 10–15 µm thick, K–, N± orange-brown. *Asci* 8-spored, 45–55 × 10–15 µm, clavate, of the *Bacidia*-type, with a prominent amyloid tholus and a conical, weakly amyloid masse axiale; ocular chamber lacking or weakly developed. *Paraphyses* simple, 1.5–2.5 µm wide; apices prominently enlarged to 5–7 µm, with the terminal cells coated with pigment. *Ascospores* ellipsoid, hyaline, thin-walled, non-halonate, (10–) 11.5–*14.4*–17 (–20) × (4–) 4.5–*5.0*–5.5 (–6) µm, 1-septate. *Pycnidia* not seen. *Chemistry*: no substances detected by t.l.c. **Fig. 1D, 2C.**

*Remarks. Lecania turicensis* is a widespread species that has been recorded for most continents and regions of the world, excluding Antarctica [see Fletcher et al. (2009) and van den Boom & Ryan (2004), who also provide descriptions]. In Australia, van den Boom & Mayrhofer (2007) record this species for South Australia, Western Australia and New South Wales; it is recorded here for Tasmania (Flinders Island) for the first time. It is characterised chiefly by its lecanorine apothecia with greyish-pruinose discs and a pale, grey-pruinose margin (Tab. 1). The species has been reported from a wide range of natural and man-made calcareous substrata. The collections studied here have somewhat longer ascospores than reported in the literature. Northern Hemisphere workers, for example Fletcher et al. (2009), report ascospores 10.5–13 µm long, although these accounts perhaps simply re-iterate the dimensions given by Mayrhofer (1988) in her study of the genus in Europe. An examination of two European specimens found that one (*A. Vězda, Lich. Sel. Exsicc. 2411*) had ascospores of the same dimensions as those of Australian material.

Australian specimens studied occurred on dry limestone outcrops in coastal heathland and roughly cleared pasture. Associated species included such typical calciphiles as *Buellia albula* and a diverse range of *Caloplaca* species, including *C. yorkensis*, *C. johnwhinrayi*, *C. cranfieldii*, *C. kantvilasii* and *C. mereschkowskiana*.

*Specimens examined:*

South Australia. **Kangaroo Island:** Red House Bay, 35°49'S 138°06'E, 15 m alt., 17 Sep. 2013, *G. Kantvilas 311/13* (herb. v.d. Boom, HO); Cape Willoughby, 35°51'S 138°08'E, 10 m alt., 24 Sep. 2013, *G. Kantvilas 244/13, 245/13 & B. de Villiers* (AD, herb v.d. Boom, HO); Stokes Bay, 35°37'S 137°13'E, 60 m alt., 29 Sep. 2013, *G. Kantvilas 304/13 & B. de Villiers* (herb. v.d. Boom, HO); Windmill Bay, 35°51'S 138°07'E, 20 m alt., 17 Sep. 2012, *G. Kantvilas 477/12* (herb. v.d. Boom, HO); Penneshaw near Frenchmans

Rock, 35°43'S 137°57'E, 2 m alt., 30 Sep. 2013, *G. Kantvilas 193/13* (herb. v.d. Boom, HO).

Tasmania. **Flinders Island:** Trousers Point, 40°13'S 148° 02'E, 5 m alt., 23 Mar. 2014, *G. Kantvilas 366/14* (CANB, HO).

## Acknowledgements

We thank Jean Jarman for the photographs that illustrate this paper, and for preparing the line drawings for publication. Some of the material studied in this project was collected during a Bush Blitz survey co-funded by the Australian Government and BHP Billiton. Laboratory work was supported in part by an Australian Biological Resources Study Tactical Taxonomy Grant to the first author.

## References

Elix, J.A. & Kantvilas, G. (2013a). New taxa and new records of *Amandinea* (Physciaceae, Ascomycota) in Australia. *Australasian Lichenology* 72: 3–19.

Elix, J.A. & Kantvilas, G. (2013b). New taxa and new records of *Buellia* sensu lato (Physciaceae, Ascomycota) in Australia. *Australasian Lichenology* 73: 24–44.

Fletcher, A., James, P.W. & Purvis, O.W. (2009). *Lecania* A. Massal. (1853). In: Smith, C.W., Aptroot, A., Coppins, B.J., Fletcher, A., Gilbert, O.L., James, P.W. & Wolseley, P.A. (eds), *The lichens of Great Britain and Ireland*, pp. 454–463. (British Lichen Society: London).

Hafellner, J. (1984). Studien in Richtung einer natürlicheren Gliederung der Sammelfamilien Lecanoraceae und Lecideaceae. *Beihefte zur Nova Hedwigia* 79: 241–371.

Kantvilas, G. & Elix, J.A. (2014). Additions to the genus *Lecidella* (lichenised Ascomycetes: Lecanoraceae). *Journal of the Adelaide Botanic Gardens* 27: 41–45.

Kantvilas, G. & Kondratyuk, S.Y. (2013). New species of *Caloplaca* (lichenized Ascomycetes: Teloschistaceae) from Kangaroo Island. *Journal of the Adelaide Botanic Gardens* 26: 9–14.

Kantvilas, G. & van den Boom, P.P.G. (2013). A new saxicolous species of *Catillaria* (lichenized Ascomycetes: Catillariaceae) from Southern Australia. *Journal of the Adelaide Botanic Gardens* 26: 5–8.

Kantvilas, G. & Wedin, M. (2015). Lichenicolous species of the Ascomycete genus *Arthonia* Ach. from Kangaroo Island. *Journal of the Adelaide Botanic Gardens* 29: 1–6.

Kirk, P.M., Cannon, P.F., David, J.C. & Stalpers, J.A. (2001). *Dictionary of the fungi*. (CABI Publishing: Wallingford).

McCarthy, P.M. (2015). *Checklist of the lichens of Australia and its island territories.* (Australian Biological Resources Study: Canberra). www.anbg.gov.au/abrs/lichenlist/introduction.html [Version 1 July 2015].

McCarthy, P.M. & Kantvilas, G. (2013a). *Psoroglaena halmaturina* sp. nov. (lichenized Ascomycota: Verrucariaceae) from Kangaroo Island, South Australia. *Journal of the Adelaide Botanic Gardens* 26: 1–4.

McCarthy, P.M. & Kantvilas, G. (2013b). Two new species of *Sarcogyne* (lichenized Ascomycota: Acarosporaceae) from central and southern Australia. *Journal of the Adelaide Botanic Gardens* 26: 15–21.

Mayrhofer, M. (1988). Studien über die saxicolen Arten der Flectengattung *Lecania* in Europa II. *Lecania* s.str. *Bibliotheca Lichenologica* 28: 1–133.

Meyer, B. & Printzen, C. (2000). Proposal for a standardized nomenclature and characterization of insoluble lichen pigments. *Lichenologist* 32: 571–583.

van den Boom, P.P.G. & Mayrhofer, H. (2007). Notes on *Lecania* species from Australasia, with the description of a new variety and a new combination in *Halecania. Australasian Lichenology* 60: 26–33.

van den Boom, P.P.G. & Ryan, B.D. (2004). *Lecania*. In: Nash III, T.H., Ryan, B.D., Diederich, P., Gries, C. & Bungartz, F. (eds), *Lichen flora of the Greater Sonoran Desert region* 2: 143–171. (Lichens Unlimited: Tempe).

*Journal of the Adelaide Botanic Gardens* 29 (2016) 23–36


# The *Solanum petrophilum* complex (Solanaceae) revised, with the description of three new species

*A.R. Bean*

Queensland Herbarium, Brisbane Botanic Gardens, Mt Coot-tha Road, Toowong, Queensland 4066
*E-mail*: tony.bean@dsiti.qld.gov.au

## Abstract

Five species are here recognised for the *Solanum petrophilum* F.Muell. complex. They are the previously named *S. petrophilum* F.Muell. and *S. eardleyae* Symon, and three newly described species: *S. lobatum* A.R.Bean, *S. osteocarpum* A.R.Bean and *S. pallidifolium* A.R.Bean. All taxa are illustrated, described, and their distributions mapped. A key is provided for their identification.

**Keywords:** *Solanum*, Solanaceae, revision, taxonomy, morphology, stellate hairs, new species, central Australia.

## Introduction

Mueller (1853) described *Solanum petrophilum* from specimens he collected in the Flinders Ranges of South Australia. Black (1926) subsequently applied the name widely in that state to any *Solanum* with stellate hairs, sinuately lobed leaves and a prickly calyx, and included specimens from the far north-west. Symon (1981) had a similar broad concept of *S. petrophilum*, encompassing populations from the ranges of northern S.A. and southern N.T., as well as populations from the Goldfields region of W.A. and near Broken Hill in N.S.W. He did note subtle differences between plants found in the Gawler Ranges and those found in the Flinders Ranges, and greater differences in the plants from central Australian ranges, for which he suggested subspecific status might be appropriate. He separated *S. eardleyae* from the complex, but did not proceed any further in segregating the taxa within *S. petrophilum* sens. lat.

The current study identifies three new species from central Australia that are related to *S. petrophilum*, but each differing in several characters from it. They are described here as *S. lobatum, S. osteocarpum* and *S. pallidifolium*. All of the populations from the more southerly areas (Gawler Ranges, Flinders Ranges, Broken Hill, goldfields area of Western Australia) are included under *S. petrophilum. Solanum eardleyae* is maintained with its current circumscription.

*Solanum petrophilum* and its allies belong to the *S. hystrix* group (Whalen 1984). This group is characterised by the non-accrescent calyx, the acicular prickles on stems and leaves, the prominent prickles on the calyx, prickles present on the leaves, the adult leaves lobed, and the corolla rotate with its inner surface glabrous. The *S. petrophilum* complex is further defined by the lack of simple hairs, the attenuate linear calyx lobes and the fruits becoming white and bony at maturity.

### Distribution and habitat

The distribution of all species of this complex is highly correlated to the occurrence of rocky hills and ranges. The two already named species, *S. petrophilum* and *S. eardleyae*, often occur also on flat or undulating terrain, while the three new species appear to be confined to rocky habitats, or within a few hundred metres of rock outcrops.

Sometimes two species of the complex occur together. For example, *Canty & Robinson BS23-24236* (AD) and *Canty & Robinson BS23-24243* (AD) were both collected from the same 100 × 100 metre quadrat near Mt Woodroffe. The former is *S. eardleyae* while the latter is *S. lobatum*.

## Selected morphological characters

### Degree of leaf lobing

The degree of lobing on the leaves is measured by the "lobing index", where the index is the length of a lobe (measured along the lateral vein) midway along the leaf divided by the parallel length at the adjacent sinus (Bean 2004: 642). This is an important character for distinguishing taxa in the complex. *S. lobatum* has a deeply lobed leaf (index (1.8–) 2.2–4.5); *S. eardleyae* can be entire or with very shallow lobes (index 1–1.2); S. *pallidifolium* is consistently shallowly lobed (index 1.2–1.8), while *S. osteocarpum* and *S. petrophilum* leaves can be shallowly or deeply lobed (index 1.2–2.5).

### Stellate hair types

Ordinarily, a stellate hair on a *Solanum* species has a central ray and a number of lateral rays (often eight) arranged like the spokes of a wheel in a single plane, i.e.

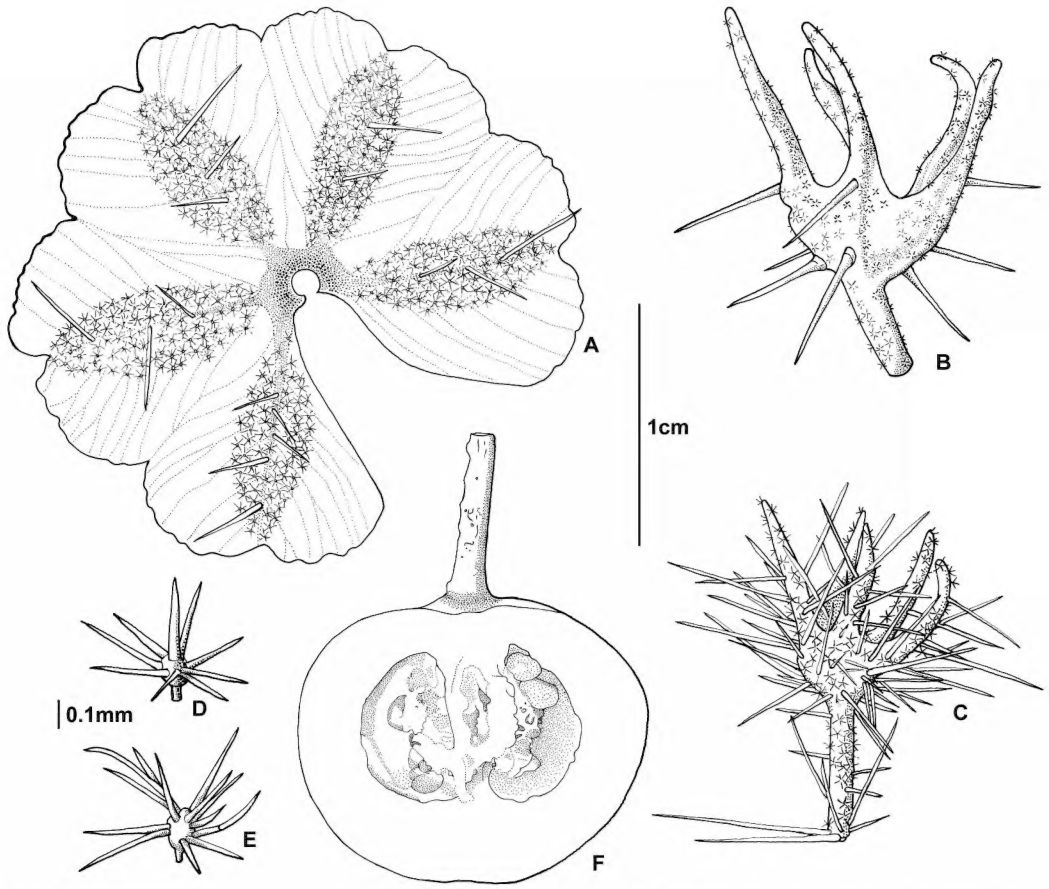


**Fig. 1. A *Solanum eardleyae***, outer surface of corolla showing prickles along radial veins. **B *S. petrophilum***, calyx and prickles. **C *S. lobatum***, calyx and prickles. **D *S. osteocarpum***, porrect stellate hair from lower leaf surface. **E–F *S. pallidifolium***: **E** 2–3-tiered stellate hair from lower leaf surface; **F** longitudinal section of fruit. — Scale bars: A–C, F = 10 mm; D–E = 0.1 mm. — **A** *P.D. Symon s.n.* (AD 98567792); **B** *B.J. Blaylock 482* (AD); **C** *N.N. Donner 6551* (AD); **D** *Hj. Eichler 17480* (AD); **E** *D.J. Whibley 6480* (AD); **F** *D.E. Murfet BS23-27433* (AD).

## Key to the species of the *Solanum petrophilum* complex

**1.** Calyx prickles 10–35 per flower
- **2.** Bases of larger branchlet-prickles 0.6–1 mm wide; style strongly curved near base; 2–3-tiered stellate hairs absent . . . . . **S. petrophilum**
- **2:** Bases of larger branchlet-prickles 0.2–0.6 mm wide; style erect or slightly off-centre (not or scarcely curved near base); 2–3-tiered stellate hairs present . . . . . **S. pallidifolium**

**1:** Calyx prickles 35–150 per flower
- **3.** Upper surface bright green with stellate hairs sparse, individual hairs 0.6–1.1 mm diameter; leaves deeply lobed, lobing index (1.8–) 2.2–4.5 . . . . . **S. lobatum**
- **3:** Upper leaf surface grey-green, grey or silvery, with stellate hairs moderately dense to very dense, individual hairs 0.4–0.8 mm diameter; leaves entire or shallowly lobed, lobing index 1–2.5
  - **4.** Leaves entire or with very shallow lobes (lobing index 1–1.2); inflorescences 8–15-flowered; upper surface of leaf with very dense indumentum . . . . . **S. eardleyae**
  - **4:** Leaves more distinctly lobed (lobing index 1.2–1.8); inflorescences 2–5 (–9)-flowered; upper surface of leaf with moderately dense to very dense indumentum
    - **5.** 2–3-tiered stellate hairs absent, or rarely present on lower leaf surface (7–8 (–13) lateral rays); anthers 4.9–6.1 mm long; leaves elliptical . . . . . **S. osteocarpum**
    - **5:** 2–3-tiered stellate hairs (with 12–25 lateral rays) common on lower surface of leaves, especially along mid-vein, and occasional to common on upper leaf surface; anthers 3.3–4.0 mm long; leaves ovate to broadly ovate . . . . . **S. pallidifolium**

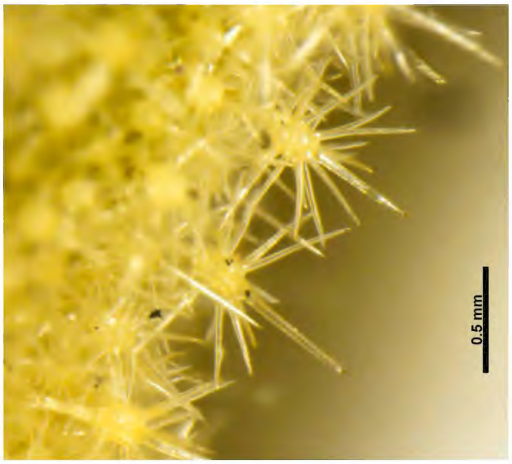


**Fig. 2.** Lower leaf surface of ***Solanum pallidifolium***, showing 2–3-tiered hairs. — *D. Edinger et al. 1891* (PERTH).

1-tiered (Fig. 1D). If the lateral rays are at right angles to the central ray, they are termed 'porrect', if the angle is less than 90 degrees, they are termed 'ascending'. In *S. pallidifolium* and occasionally in *S. lobatum* and *S. osteocarpum*, hairs occur where the lateral rays are inserted at various points on an enlarged hub, forming two or three tiers of lateral rays, more or less parallel to each other. In this hair type, the central ray is quite discernible, and the number of lateral rays ranges from 12 to 25 (Fig. 1E, 2). This hair type is here termed a 2–3-tiered stellate hair, and it is a type rarely found elsewhere in Australian members of the genus. This hair is different from the multangulate hair of Roe (1971), as that hair type has rays arranged in a random manner forming a globose urchin-like structure where the central ray is indistinguishable.

The 2–3-tiered hair is found on a few collections of *S. lobatum*, and then only on the branchlets or the lower leaf surface. Similarly, it is found on a few collections of *S. osteocarpum*, and then only on the lower leaf surface. In the case of *S. pallidifolium*, 2–3-tiered hairs are found on all collections, and they occur on the branchlets, upper leaf surface, lower leaf surface, the inflorescence rachis and the calyx. Their frequency varies from occasional to abundant.

### Stellate hair density

The terminology used for the density of the stellate hairs follows Bean (2004); the stellate hairs overlap for "very dense", "dense" and "moderately dense", while in "sparse" and "very sparse", they do not overlap. The density of hairs on the upper leaf surface is diagnostic in the *S. petrophilum* complex. *S. lobatum* is notable for its sparse indumentum, and this correlates with the bright green appearance of the upper surface. *S. petrophilum* varies from sparse to moderately dense. *S. eardleyae* consistently has very dense indumentum on the upper leaf surface, and *S. pallidifolium* and *S. osteocarpum* both vary from moderately dense to very dense.

### Prickle density and distribution on leaves, branchlets and calyx

The distribution and density of prickles can be a useful character for separating the species in this group. *S. petrophilum* consistently has a low number of prickles (10–35) on the calyx, all other species tend to have very high numbers of prickles on the calyx (35–150), although some populations of *S. pallidifolium* have flowers that may bear as few as 15 prickles.

The density of prickles on the branchlets is quite variable, but *S. petrophilum* tends to have sparser prickles (2–9 per cm) than the other species.

The number of prickles on the upper leaf surface is somewhat diagnostic; *S. petrophilum* and *S. eardleyae* have the lowest numbers, 2–18 and 3–21 respectively. The other species tend have more prickles: 6–23 for *S. osteocarpum*, 5–57 for *S. lobatum*, and 8–16 for *S. pallidifolium*.

### Flower number

The number of flowers in each cyme is diagnostic for the group. *S. eardleyae* has 8–15 flowers per inflorescence, often with an elongated rachis. *S. pallidifolium* has 1–5 flowers per inflorescence. *S. lobatum* usually has 6–11 flowers per inflorescence, but sometimes as few as three. *S. osteocarpum* generally has a short inflorescence with 2–5 flowers, but sometimes up to nine. *S. petrophilum* has 3–5 (–7) flowers.

### Corolla prickles

In my observation, the presence of prickles on the outer surface of the corolla is another feature seemingly restricted to the *Solanum hystrix* group (member species listed in Bean 2004). Symon (1981: 7) mentioned that *S. hystrix* R.Br. and *S. hoplopetalum* Bitter & Summerh. bear prickles on the corolla, but during the present study, it has become clear that this character is more widespread. All flowering specimens of *S. eardleyae* bear five to 25 prickles along the main radial veins of the corolla of each flower (Fig. 1A). Some collections of *S. osteocarpum, S. pallidifolium,* and *S. lobatum* have prickles along the main radial veins of the corolla (usually only 5–10 per flower), while on other collections there are none. Only *S. petrophilum* is consistently without corolla prickles.

## Materials and methods

This study is based on detailed morphological examination of herbarium specimens from PERTH, AD, BRI, CANB, DNA and NT. Measurements are based on dried material, except for those of the flower (style, anthers and corolla) where reconstituted material was measured. The format of the descriptions follows Bean (2004). Distribution maps have been compiled with DIVA-GIS Version 7.5.0, using localities or geocodes given on the labels of specimens from the herbaria listed above.

## Taxonomy

***Solanum eardleyae* Symon**

J. Adelaide Bot. Gard. 4: 212 (1981). **Type:** Northern Territory: Duffield Rocks, c. 91 km NE of Mt Davies Camp, 25° 36'S 129° 44'E, 1 October 1970, *P.K. Latz 939* (holo: NT; iso: AD, CANB, MEL).

*Solanum petrophilum* auct. non F.Muell.: D.E.Symon in Jessop (ed.), Fl. Central Austral. 318 (1981), pro parte.

*Illustration:* Symon (1981: 213).

Erect rhizomatous perennial shrub, 0.5–2 m high. *Branchlets* terete, yellow, rusty or brown; prickles 18–76 per cm, straight and acicular, 2–9 mm long, 0.2–0.6 mm wide at base, 11–15 times longer than wide, glabrous; hairs stellate; stellate hairs very dense, 0.55–0.8 mm diameter, stalks 0–0.3 mm long, lateral rays 7–8, porrect or ascending, central ray 0.8–1.2 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; short glandular hairs absent. *Leaves* elliptical or ovate, 4.1–11.8 cm long, 1.4–4.5 cm wide, 1.4–3.3 times longer than broad, entire or shallowly lobed throughout; lobes 0–7 on each side, obtuse, lobing index 1–1.2; apex obtuse or acute, base cuneate or obtuse or cordate, oblique part 2–6 mm long, obliqueness index (Bean 2004) 3–7 percent; petioles 1.2–3 cm long, 21–32 % length of lamina, prickles present, indumentum not floccose. *Upper leaf surface* grey; prickles present on midvein only, 1–7, straight and acicular, 4–7 mm long; stellate hairs distributed throughout, very dense, c. 0.05 mm apart, 0.6–0.8 mm across, stalks 0–0.1 mm long; lateral rays 7–8, porrect or ascending; central ray 0.8–1.2 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. *Lower leaf surface* white to grey; prickles present on midvein only or present on midvein and lateral veins, 3–21, straight and acicular. Lower leaf surface stellate hairs very dense, not floccose, c. 0.05 mm apart, 0.5–0.7 mm diameter, stalks 0–0.2 mm long; lateral rays 7–8, porrect or ascending; central ray 0.7–1.2 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. *Inflorescence* supra-axillary, cymose (pseudo-racemose), common peduncle 10–21 mm long, rachis prickles present, 8–15-flowered, with all flowers bisexual; flowers 5-merous; pedicels at anthesis 1–5 (–9) mm long, same thickness throughout, prickles absent or present. Calyx tube at anthesis 2–4 mm long; lobes attenuate, 5–9 mm long; prickles present, 75–140 per flower, 0.5–4.5 mm long; stellate hairs very dense, white or transparent, 0.55–0.7 mm across, stalks 0–0.3 mm long, lateral rays 7–8, central ray 0.8–1.2 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. Corolla purple, 16–23 mm long, rotate; outer surface with prickles, prickles 5–25; inner surface glabrous. Anthers 5–6.2 mm long; filaments 0.9–1 mm long; ovary with short glandular hairs only; functional style 11.5–13 mm long, erect or slightly off-centre near its base then recurved towards apex, glabrous or with short glandular hairs only. Fruiting calyx lobes exceeding mature fruit, prickles 1.5–5 mm long. Mature fruits 3–6 per inflorescence, globular, 12–14 mm diameter, yellow or white, pericarp c. 2 mm thick, pedicels 2–8 mm long. **Fig. 1A, 3.**

*Distribution & habitat. Solanum eardleyae* is common in the Musgrave Range and Everard Range areas of far northern South Australia, and it extends into Northern Territory as far north as Mt Zeil and Mt Hay, and west to Duffield Rocks. There is also a single collection (*Symon 17331 & Symon*, AD) from the Stuart Highway far to the south of any other populations (Fig. 5). It is apparently absent from the areas around the Mann Ranges and Tomkinson Ranges. It inhabits hills and mountains, and the sandy plains and sandy colluvia adjacent to them, particularly appearing beside tracks where there has been recent disturbance.

One herbarium label (*Bates 58153*, AD) states that *S. eardleyae* is "the commonest [Solanum] species around the Musgraves". The single plant collected from the Stuart Highway (*Symon 17331 & Symon*) presumably resulted from seeds inadvertently brought there in road building material.

*Notes. Solanum eardleyae* is most readily distinguished by its entire or very shallowly lobed adult leaves, the very dense indumentum on both leaf surfaces, and the large number of flowers per inflorescence. It is the tallest species of the complex, reportedly reaching two metres in height. Some populations of *S. osteocarpum* can also have a very dense indumentum on the leaves, but the leaves of *S. osteocarpum* are considerably more deeply lobed (lobing index 1.5–2.3) and it has only 2–5 (–9) flowers per inflorescence.

*Specimens examined:*

Northern Territory: Mulga Park, *Anon. s.n. [Pastoral Board]* (AD 98027031); Lake Cotterill, George Gill Ra., 8 July 1968, *A.C. Beauglehole 25937* (AD); Lower Gorge, Kings Canyon, George Gill Ra., 8 July 1968, *A.C. Beauglehole 26095* (AD); Mt Connor, 17 June 1974, *G.W. Carr 1854 & A.C. Beauglehole 45633* (AD, DNA); Yununba Hill, c. 15 km ESE of Mulga Park Hmsd, 21 Aug. 1973, *N.N. Donner 4329* (AD, BM); 6 km E of Kulgera on Finke road, 20 May 1988, *M.D. Kimbel 119* (DNA, NT); Curtin Springs area, base of Mt Connor, 27 Apr. 1974, *P.K. Latz 4980* (DNA); Mt Frazer, N Musgrave Ra., 29 Apr. 1974, *P.K. Latz 5058* (DNA); Mt Hay, 20 km W of Hamilton Downs Hmsd, 16 Aug. 1995, *P.K. Latz 14474* (DNA); 16 km W of Erldunda Hmsd, 2 Aug. 1997, *P.K. Latz 15381* (DNA, MEL, NT); 30 km N of Ernabella, 20 Nov. 1999, *P.K. Latz 16054 & D.E. Albrecht* (NT); SW slopes of Mt Connor, 11 June 1975, *D.E. Symon 10386* (AD, CANB, DNA); Mt Zeil, W side of mountain, 25 Nov. 1988, *B.G. Thomson 2730* (DNA, NT).

South Australia: Alcurra Ck, 23 Apr. 2001, *R. Bates 58153* (AD); Mitchell Nob, 7 May 2001, *R. Bates 58496* (AD); 10 km NNE from Mt Woodroffe, 2.2 km direct SSW of Ngarutjara, 15 Oct. 1994, *P.D. Canty & A.C. Robinson BS23-24236* (AD); SW of Mt Cuthbert, 16 July 1982, *P.E. Conrick 799* (AD); 7.5 km SW from Womikata Bore Homeland, 22 Feb. 1995, *P.B. Copley & S.J. Pillman BS23-24533* (AD);


**Fig. 4.** Representative specimen of ***S. lobatum*** (*Hj. Eichler 17346*, AD).


**Fig. 3.** Representative specimen of ***Solanum eardleyae*** (*R. Hill 707 & T.R. Lothian*, AD).

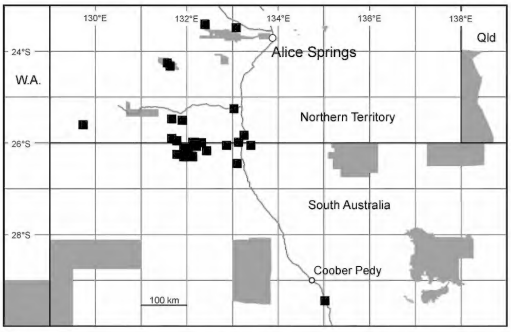


**Fig. 5.** Distribution of ***Solanum eardleyae***.

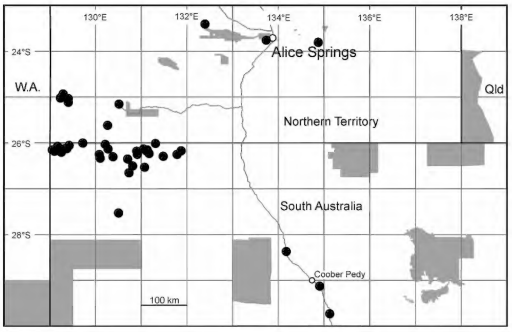


**Fig. 6.** Distribution of ***S. lobatum***.

Track between Ernabella and Mt Woodroffe turnoff, 30 June 1958, *R. Hill 707 & T.R. Lothian* (AD, BH, G, P); 17.7 km E of Ngarutjara, APY Lands, 11.6 km direct WSW of Mt Cuthbert, 18 Oct. 1994, *P.J. Lang BS23-24439* (AD); 5 km S of NT border on Tarcoola–Alice Springs railway, 20 Aug. 1979, *B. Lay 1246* (AD); 10 miles [16 km] N of Kenmore Park Stn, 12 Aug. 1962, *D.E. Symon 2705* (AD); Stuart Hwy, 60 km S of Coober Pedy, 41 km N of Glendambo, 11 Jan. 2009, *D.E. Symon 17331 & J. Symon* (AD, NT); Vicinity of Ernabella Mission, 13 June 1976, *P.D. Symon s.n.* (AD 98567792); Ernabella, E end of Musgrave Ra., 21 May 1966, *F.T. Turvey s.n.* (AD); 0.5 km S of Ernabella, 21 Sep. 1990, *P.G. Wilson 777 & R. Rowe* (AD).

***Solanum lobatum* A.R.Bean, *sp. nov.***

*With affinity to S. petrophilum, but differing by the more deeply lobed adult leaves, greater number of prickles on the leaves, the larger stellate hairs of the upper leaf surface, and the greater number of calyx prickles (75–150 per flower).*

**Type:** South Australia: At foot of Mt Harriet, Musgrave Range, 5 September 1963, *D.J.E Whibley 932* (holo: AD!; iso: AAU, M, NY, all n.v.).

*Solanum petrophilum* auct. non F.Muell.: D.E.Symon in Jessop (ed.), Fl. Central Austral. 318 (1981), pro parte; D.E.Symon, Rev. genus Solanum in Austral., J. Adelaide Bot. Gard. 4: 214 (1981), pro parte; R.W.Purdie et al. in A.S.George (ed.), Fl. Austral. 29: 149 (1982), pro parte; D.E.Symon in Jessop & Toelken (eds), Fl. S. Austral., ed. 4, 3: 1269 (1986), pro parte; W.R.Barker et al. (eds), J. Adelaide Bot. Gard. Suppl. 1: 124 (2005), pro parte; P.S.Short et al. (eds), Checkl. Vasc. Pl. N. Territory 71 (2011).

*Illustration:* Barker (2010), left-hand photo (Pitjantjara Lands, A. Robinson).

Erect rhizomatous perennial shrub, 0.3–0.6 m high. *Branchlets* terete, yellow, grey, rusty or brown; prickles 10–46 per cm, straight and acicular, 1.5–11 mm long, 0.2–0.6 mm wide at base, 11–18 times longer than wide, glabrous; hairs stellate; stellate hairs very dense, 0.4–0.8 mm diameter, stalks 0–0.2 mm long, lateral rays 7–8 (–23), porrect, ascending or rarely 2–3-tiered; central ray 0.8–2 times as long as laterals, not gland-tipped; short glandular hairs absent. *Leaves* elliptical or ovate, 3.0–8.5 cm long, 1.1–4.1 cm wide, 1.7–4.1 times longer than broad, deeply lobed throughout, or occasionally shallowly lobed; lobes 4–8 on each side, obtuse, lobing index (1.8–) 2.2–4.5; apex obtuse, base cuneate, cordate or obtuse, oblique part 0–11 mm long, obliqueness index 0–7 percent; petioles 0.8–2.5 cm long, 18–36 % length of lamina, prickles present, indumentum not floccose. *Upper leaf surface* green; prickles present on midvein and lateral veins, 9–56, straight and acicular, 1.5–11 mm long; stellate hairs distributed throughout, sparse, 0.35–1.0 mm apart, 0.6–1.1 mm across, stalks 0–0.1 mm long; lateral rays 6–8, porrect; central ray 1.0–2.0 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. *Lower leaf surface* white to grey or yellowish; prickles present on midvein and lateral veins, 5–57, straight and acicular. Lower leaf surface stellate hairs dense to very dense, not floccose, 0.05–0.25 mm apart, 0.6–1.0 mm diameter, stalks 0–0.3 mm long; lateral rays 7–8 (–25), porrect or ascending, rarely 2–3-tiered; central ray 1.0–2.0 times as long as laterals, not gland-tipped; simple hairs absent; short glandular hairs absent. *Inflorescence* leaf-opposed or supra-axillary, cymose (pseudo-racemose), common peduncle 6–41 mm long, rachis prickles present, (3–) 6–11-flowered, with all flowers bisexual; flowers 5-merous; pedicels at anthesis 3–7 mm long, same thickness throughout, prickles absent or present. Calyx tube at anthesis 1.5–3.5 mm long; lobes attenuate, 3.5–10 mm long; prickles present, 75–150 per flower, 1–7.5 mm long; stellate hairs dense to very dense, white or transparent or purplish, 0.4–0.7 mm across, stalks 0–0.2 mm long, lateral rays 6–8 (–16), porrect, ascending, or rarely 2–3-tiered; central ray 1.0–2.0 times as long as laterals, not gland-tipped; simple hairs absent; short glandular hairs absent. Corolla purple, 12–16 mm long, rotate; outer surface with or without prickles, prickles 0–10; inner surface glabrous. Anthers 4.1–5.6 mm long; filaments 1–1.5 mm long; ovary glabrous or with short glandular hairs only; functional style 8.5–11 mm long, erect or slightly off-centre near its base then recurved towards apex, glabrous or with short glandular hairs only. Fruiting calyx lobes more than half length of mature fruit or exceeding mature fruit, prickles 1.5–7 mm long. Mature fruits 1–7 per inflorescence, globular, c. 12 mm diameter, yellow or white, pericarp 1–1.5 mm thick, pedicels 5.5–10 mm long. **Fig. 1C, 4.**

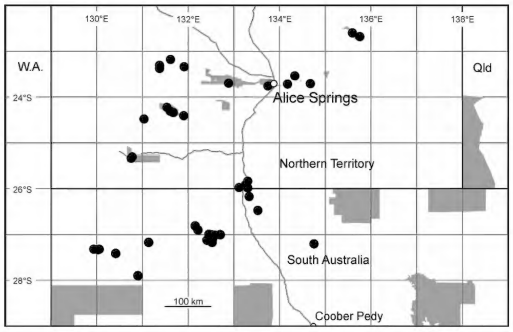


**Fig. 7**. Distribution of ***S. osteocarpum***.

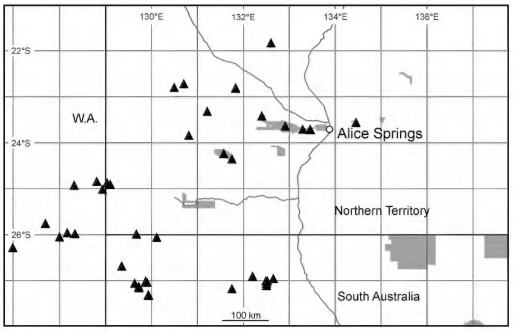


**Fig. 8.** Distribution of ***S. pallidifolium***.

*Distribution & habitat. Solanum lobatum* is found mainly in far south-western N.T. (Petermann Ranges), and in the western Musgrave Ranges, the Mann Ranges and the Tomkinson Ranges of far northern South Australia, but extends as far north as Alice Springs and south to some isolated mountains south of the Musgrave Ranges (e.g. Mt Crombie, Mt Harriet). There are also three recent collections from the Stuart Highway (Fig. 6). This species grows on or adjacent to rocky outcrops and hills, at least some of which are granitic in origin. Soils are shallow to deep sands.

The recent specimen records from the Stuart Highway (*Symon 16116, 17392 & 17393*) were all from isolated plants immediately beside the highway. It is presumed that these resulted from seeds inadvertently brought there in road building material.

The westernmost herbarium record of *S. lobatum* in South Australia (in the Tomkinson Ranges) is only about 10 km from the Western Australian border, so it seems highly likely that this species will eventually be found in the latter state.

*Notes.* Some specimens from the Tomkinson Range (e.g. *N.N. Donner 6551*) have very few flowers per inflorescence, the leaves are not as deeply lobed, and the indumentum includes some 2–3-tiered stellate hairs. These specimens may represent a distinct taxon, but more specimens and observations are needed before this can be decided.

*Etymology*. The epithet refers to the deeply lobed adult leaves, which are more dissected than in any other species of the complex.

*Specimens examined:*

Northern Territory: Mt Zeil, 0.5 km S of summit, 10 July 1998, *D.E. Albrecht 8667* (NT); 3 km NE of Butler Dome summit, 84 km WSW of Uluru, 17 Oct. 2010, *D.E. Albrecht 13269 & P.K. Latz* (NT); Lasseter's Cave, Hull R., 24 June 1958, *G. Chippendale 4610* (DNA); Petermann Ra. Res., Mannanana Ra., 10 Sep. 1978, *T.S. Henshall 2184* (DNA); Petermann Ra., 24 Sep. 1971, *P.K. Latz 1777* (DNA); 8 km NNW of Ringwood Stn Hmsd, 19 Nov. 2001, *P.K. Latz 18342* (NT); 22 km ESE of Angatja, 63 km W of Amata, 31 Aug. 2009, *P.K. Latz 24721* (AD, NT); Temple Bar Stn, 1 June 1993, *D.J. Nelson 2872* (DNA, NT); Mt Zeil, summit, 6 Sep. 1999, *J. Risler & R.A. Kerrigan 288* (DNA, NT).

South Australia: S facing slopes of Hinckley Ra., Tomkinson Ra., c. 7 km by road W of main Pipalyatjara (Mt Davies Camp)–Wingellina road, 4 Sep. 1978, *W.R. Barker 3212* (AD); W end of Musgrave Ra., c. 2 km N of No. 25 Bore, c. 25 km direct WSW of Amata, 11 Sep. 1978, *W.R. Barker 3509* (AD); 1 km SE from Hanging Knoll, 6 May 1993, *P.D. Canty & J.S. Gillen BS23-23590* (AD); 14 km ENE from Mt Cooparinna, 5 May 1994, *P.D. Canty et al. BS23-23842* (AD); 9 km SSE from Mitchell Nob, 18 Oct. 1994, *P.D. Canty & A.C. Robinson BS23-24179* (AD); 10 km NNE from Mt Woodroffe, 2.2 km direct SSW of Ngarutjara, 15 Oct. 1994, *P.D. Canty & A.C. Robinson BS23-24243* (AD); Cave Hill, Musgrave Ra., 18 June 1958, *J.B. Cleland s.n.* (AD); Tomkinson Ra., 25 Aug. 1954, *J.B. Cleland s.n.* (AD); Mt Davies in Tomkinson Ra., c. 15 km E of WA border and 20 km S of NT border, 29 June 1960, *J.B. Cleland s.n.* (AD); N side of Mt Crombie, approximately 60 km SSW of Amata, 16 Sep. 1985, *P. Copley 1352* (AD); 8 km W of Mt Crombie, 16 Sep. 1985, *P. Copley 1425* (AD); Creek c. 2.5 km NW of Mt Davies Camp, 4 Sep. 1978, *N.N. Donner 6551* (AD); Between Deering Hills and Mann Ra., c. 18 km NE of Mt Cooperinna, 9 Sep. 1978, *N.N. Donner 6622* (AD, DNA); W slope to summit of Mt Morris, 7 Sep. 1963, *Hj. Eichler 17346* (AD); 7.6 km direct ENE of Yurangka, 20 Oct. 1998, *P.J. Lang & P.D. Canty BS23-28913* (AD); Musgrave Park, c. 55 km WNW of Mt Woodroffe, Aug. 1963, *R. Lange 4* (AD); College Glen, E Mann Ra., 17 May 1991, *P.K. Latz 11863* (AD, DNA, NT); Piltardi rock hole, Mann Ra., 21 Sep. 1958, *W.S. Reid 75* (AD); Mt Harriet, SW from Mt Woodroffe, Musgrave Ra., 1 Oct. 1955, *W.S. Reid s.n.* (AD); c. 0.75 km W of road to Waltjitjata, c. 6.5 km by road NNE of turnoff from Pipalyatjara to Putaputa road, Tomkinson Ra., 6 Sep. 1978, *K. Stove 499* (AD); 3 miles N of Mt Davies Camp, Tomkinson Ra., 5 Aug. 1962, *D.E. Symon 2536* (AD); 12 miles S of Cheesmans Peak Corner, 7 Aug. 1962, *D.E. Symon 2596* (AD); 58 km S of Cadney Park on main road, 17 km N of turnoff to Murloocoppie Rockhole, 29 Jan. 2000, *D.E. Symon 16116 & J. Symon* (AD); Stuart Hwy, 19 km S of Coober Pedy, 11 Jan. 2009, *D.E. Symon 17392 & J. Symon* (AD); Stuart Hwy, 94 km S of Coober Pedy, 160 km N of Glendambo, 11 Jan. 2009, *D.E. Symon 17393 & J. Symon* (AD); Camp 5, Arukalanda, W. Musgrave Ra., 26 June 1933, *N.B. Tindale & C.J. Hackett s.n.* (AD); SE end of Mt Caroline, Musgrave Ra., 11 Sep. 1978, *J.Z. Weber 5596* (AD); Plain between Tomkinson and Mann Ra., c. 15.5 km by road NNE of turnoff on Pipalyatjara –Putaputa road, on road to Waltjitjara, 6 Sep. 1978, *D. Whibley 6800* (AD, DNA); 5.6 km S of Amata, 21 Sep. 1990, *P.G. Wilson 771 & R. Rowe* (AD, CANB, NSW).

***Solanum osteocarpum* A.R.Bean, *sp. nov.***

*With affinity to S. petrophilum but differing by the larger stellate hairs on the lower leaf surface, the more slender prickles on all plant parts, the greater number of calyx prickles, and the longer style.*

**Type:** South Australia. Amoorinya Hill, Everard Range, c. 26 km SW of Everard Park Homestead, 13 September 1963, *Hj. Eichler 17480* (holo: AD; iso: CANB (ex CGE)).

*Solanum petrophilum* auct. non F.Muell.: D.E.Symon in Jessop (ed.), Fl. Central Austral. 318 (1981), pro parte; D.E.Symon, Rev. genus Solanum in Austral., J. Adelaide Bot. Gard. 4: 214 (1981), pro parte; R.W.Purdie et al. in A.S.George (ed.), Fl. Austral. 29: 149 (1982), pro parte; D.E.Symon in Jessop & Toelken (eds), Fl. S. Austral., ed. 4, 3: 1269 (1986), pro parte; W.R.Barker et al. (eds), J. Adelaide. Bot. Gard. Suppl. 1: 124 (2005), pro parte; P.S.Short et al. (eds), Checkl. Vasc. Pl. N. Territory 71 (2011).

Erect rhizomatous perennial shrub, 0.2–0.7 m high. *Branchlets* terete or ridged, yellow, grey rusty or brown; prickles 9–28 per cm, straight and acicular, 2–9 mm long, 0.2–0.6 mm wide at base, 15–18 times longer than wide, glabrous; hairs stellate; stellate hairs very dense, 0.5–0.7 mm diameter, stalks 0–0.3 mm long, lateral rays 6–8, porrect or ascending, central ray 1.0–1.5 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; short glandular hairs absent. *Leaves* elliptical, 3.7–7.2 cm long, 1.4–3.4 cm wide, 2.1–3.1 times longer than broad, shallowly or deeply lobed throughout; lobes 4–6 on each side, obtuse or acute, lobing index 1.2–2.5; apex obtuse or acute, base cuneate or obtuse or cordate, oblique part 1.5–8 mm long, obliqueness index 3–13 percent; petioles 0.8–2.1 cm long, 14–35 % length of lamina, prickles present, indumentum not floccose. *Upper leaf surface* green, grey-green or grey; prickles present on midvein only or on midvein and lateral veins, 6–23, straight and acicular, 2–11 mm long; stellate hairs distributed throughout, moderately dense to very dense, 0.05–0.4 mm apart, 0.5–0.75 mm across, stalks 0–0.2 mm long; lateral rays 7–8, porrect or ascending; central ray 0.8–1.5 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. *Lower leaf surface* white to grey or greenish-white; prickles present on midvein and lateral veins, 16–36, straight and acicular. Lower leaf surface stellate hairs dense to very dense, not floccose, 0.05–0.2 mm apart, 0.65–0.8 mm diameter, stalks 0–0.3 mm long; lateral rays 7–8 (–13), porrect or ascending or rarely 2–3-tiered; central ray 0.8–1.5 times as long as laterals, not gland-tipped; simple hairs absent; short glandular hairs absent. *Inflorescence* supra-axillary, cymose (pseudo-racemose), common peduncle 15–39 mm long, rachis prickles present, 2–5 (–9)-flowered, with all flowers bisexual; flowers 5-merous; pedicels at anthesis 2.5–9 mm long, same thickness throughout, prickles absent or present. Calyx tube at anthesis 2–4 mm long; lobes attenuate, 6–11 mm long; prickles present, (35–) 40–90 per flower, 1–5.5 mm long; stellate hairs dense to very dense, white or transparent, 0.55–0.7 mm across, stalks 0–0.2 mm long, lateral rays 7–8, central ray 0.8–1.2 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. Corolla purple, 17–26 mm long, rotate; outer surface with or without prickles, prickles 0–25; inner surface glabrous. Anthers 4.9–6.1 mm long; filaments 1–1.5 mm long; ovary glabrous; functional style 11–12 mm long, erect or slightly off-centre near its base then recurved towards apex, glabrous. Fruiting calyx lobes exceeding mature fruit, prickles 2.5–6.5 mm long. Mature fruits 1–6 per inflorescence, globular, c. 14 mm diameter, yellow or white, pericarp 1–1.5 mm thick, pedicels 8–10 mm long. **Figs. 1D, 9, 11.**

*Distribution & habitat. Solanum osteocarpum* extends from the Marshall Bore (near Harts Range) NE of Alice Springs (N.T.), south to the Cheesman Junction area and the Everard Ranges of northern S.A. (Fig. 7). It grows on or adjacent to granite, sandstone or quartzite hills and ranges, on skeletal or sandy soil. It is apparently absent from the Tomkinson, Mann, and Musgrave Ranges of far northern South Australia.

*Notes. Solanum osteocarpum* has a shallowly lobed leaf with moderately dense to very dense indumentum on the upper leaf surface. It typically has a rather short inflorescence with 2–5 flowers, though it can have up to 9 flowers. The fruits have a very thick pericarp, and over-mature fruits are very "bony". In the great majority of collections, 2–3-tiered stellate hairs are lacking, but they can be found on the lower leaf surface in a few collections.

*Solanum osteocarpum* differs from *S. lobatum* by the leaves being not as deeply lobed, with a moderately dense to very dense indumentum on the upper surface, and the individual stellate hairs of the upper surface mostly smaller. Its corolla is larger and the style is longer.

*Etymology*. The epithet is from the Greek *ostion* (bone) and *carpos* (fruit), and refers to the thick hard 'bony' outer layer of the fruit found in this species and others of the complex.

*Specimens examined:*

Northern Territory: Kathleen Springs, along boardwalk, Watarrka N.P., 11 Oct. 2005, *K.S. Baker & R.B. Brown 19* (K, NT); 7 miles [11 km] S of Kulgera Hmsd, 5 Aug. 1954, *G. Chippendale 155* (CANB, DNA); near Ulambaura Spring, Haast Bluff, 23 Aug. 1956, *G. Chippendale 2604* (BRI, DNA); Gorge near Mt Liebig, 23 July 1957, *G. Chippendale 3536* (DNA); Old Huckitta Hmsd, 20 July 1970, *P.K. Latz 665* (DNA); Mt Olga Gorge, 22 Sep 1971, *P.K. Latz 1745* (NT); Bendstead Ra., 27 July 1972, *P.K. Latz 3135* (NT); Mt Cavenagh Stn, 1 May 1974, *P.K. Latz 5215* (DNA); Glen Thirsty, 58 km SW of Kings Canyon, 14 Oct 2004, *P.K. Latz 20612* (NT); 6 km NE of Kings Ck, E George, Gill Ra., 16 Sep. 2014, *P.K. Latz 29702* (DNA, NT).

South Australia: Kathleen Waterhole, Todmorden Stn, 25 June 1992, *F.J. Badman 5452* (AD); 1 km E of Marys Well, De Rose Hill Stn, 22 Aug. 1992, *F.J. Badman 6066* (AD); c. 26 km by road due W of Cheesman Junction, c. 0.5 km W of first hill


**Fig. 10.** Representative specimen of ***S. pallidifolium*** (*D.J. Whibley 6480*, AD).


**Fig. 9.** Holotype of ***Solanum osteocarpum*** (*Hj. Eichler 17480*, AD).

**Fig. 11.** Cultivated plant of ***Solanum osteocarpum*** at Alice Springs Desert Park (ex King's Canyon). Photo: A.R. Bean.

encountered, 29 Aug. 1978, *W.R. Barker 3010* (AD); Everard Park, ESE of Mt Illbillee, 27 June 1968, *A.C. Beauglehole 25464* (AD); Betty's Ck Gorge, Everard Ra., 4 Oct. 1974, *C.D. Boomsma 56* (AD); 1.4 km NW from Carmeena Well, 0.9 km direct SSE of Mt Carmeena, 19 Sep. 1992, *P.D. Canty & P.B. Copley BS23-20866* (AD); Piltadi, Mann Ra., 21 Aug. 1954, *J.B. Cleland s.n.* (AD); Between Officer Ck and Everard Ra., 1 Sep. 1954, *J.B. Cleland s.n.* (AD); Tjatamannga Rockhole, c. 18 km by road SE of Cheesman Junction, beside road to Emu, 27 Aug. 1978, *N.N. Donner 6374* (AD); Everard Ra., gorge N of Victory Well, 12 Sep. 1963, *Hj. Eichler 17431* (AD); Everard Ra., 1 June 1891, *R. Helms s.n.* (AD); Lower foothills, Mt Illbillie, Everard Ra., 5 Sep. 1968, *D.N. Kraehenbuehl s.n.* (AD); Valley above Victory Well, Everard Ra., 23 May 2000, *P.J. Lang BS23-30022* (AD); About 80 km SE of Cheesman Peak, anno 1966, *R.B. Major 31* (AD); c. 6 km by vehicle cross-country NE of Moolalpinna Hill E end, c. 6 km S of Ampeinna Hills, 26 Aug. 1978, *J.Z. Weber 5258* (AD); c. 1.75 km WNW of summit of Mt Poondinna Rockhole, 29 Aug. 1978, *D.J. Whibley 6435* (AD, DNA).

***Solanum pallidifolium* A.R.Bean, *sp. nov.***

*With affinity to S. petrophilum but differing by the more slender prickles, the presence of 2–3-tiered stellate hairs on most plant parts, and the longer central ray of the stellate hairs on the branchlets and leaves.*

**Type:** Northern Territory: Larapinta Trail, Standley Chasm area, c. 40 km W of Alice Springs, 1 August 2006, *A.R. Bean 25450 & D.E. Albrecht* (holo: BRI; iso: CANB, NT).

*Solanum petrophilum* auct. non. F.Muell.: D.E.Symon in Jessop, (ed.), Fl. Central Austral. 318 (1981), pro parte; D.E.Symon, Rev. genus Solanum in Austral., J. Adelaide Bot. Gard. 4: 214 (1981), pro parte; R.W.Purdie et al. in A.S.George (ed.), Fl. Austral. 29: 149 (1982), pro parte; D.E.Symon in Jessop & Toelken (eds), Fl. S. Austral., ed. 4, 3: 1269 (1986), pro parte; W.R.Barker et al. (eds), J. Adelaide Bot. Gard. Suppl. 1: 124 (2005), pro parte; P.S.Short et al. (eds), Checkl. Vasc. Pl. N. Territory 71 (2011).

*Illustration:* Symon (1981: 217), as *S. petrophilum.*

Sprawling or erect rhizomatous perennial shrub, 0.3–0.6 m high. *Branchlets* terete, white, grey or brown; prickles 6–26 per cm, straight and acicular, 1–9 mm long, 0.2–0.6 mm wide at base, 10–18 times longer than wide, glabrous or with 3–8 stellate hairs at base; stellate hairs very dense, 0.5–0.7 mm diameter, stalks 0–0.3 mm long, lateral rays 8–25, porrect, ascending or 2–3-tiered, central ray 1.2–1.8 times as long as laterals, not gland-tipped; short glandular hairs absent. *Leaves* ovate to broadly ovate, 3.5–9.0 cm long, 1.6–5.0 cm wide, 1.6–2.4 times longer than broad, shallowly lobed throughout; lobes 4–7 on each side, obtuse, lobing

**Fig. 12. *Solanum pallidifolium*** plant on the Larapinta Trail, near Standley Chasm (*A.R. Bean 25450 & D.E. Albrecht*). Photo: A.R. Bean.

index 1.2–1.8; apex obtuse, base obtuse, oblique part 2–4 mm long, obliqueness index 3–6 percent; petioles 0.9–3.3 cm long, 23–42% length of lamina, prickles present, indumentum often floccose. *Upper leaf surface* grey-green or grey; prickles present on midvein and lateral veins, 8–16, straight and acicular, 1–8.5 mm long; stellate hairs distributed throughout, moderately dense to very dense, 0.05–0.4 mm apart, 0.4–0.7 mm across, stalks 0–0.2 mm long; lateral rays 6–18, porrect or ascending or 2–3-tiered; central ray 1.0–2.0 times as long as laterals, not gland-tipped; simple hairs absent; short glandular hairs absent. *Lower leaf surface* greenish-white to white; prickles present on midvein and lateral veins, 8–25, straight and acicular. Lower leaf surface stellate hairs dense to very dense, often floccose, 0.05–0.25 mm apart, 0.5–0.8 mm diameter, stalks 0–0.4 mm long; lateral rays 8–23, porrect or ascending or 2–3-tiered; central ray 1.0–2.0 times as long as laterals, not gland-tipped; simple hairs absent; short glandular hairs absent. *Inflorescence* supra-axillary, cymose (pseudo-racemose), common peduncle 15–28 mm long, rachis prickles present, 1–5-flowered, with all flowers bisexual; flowers 5-merous; pedicels at anthesis 1–4.5 mm long, same thickness throughout, prickles absent or present. Calyx tube at anthesis 1.5–3.5 mm long; lobes attenuate, 3–10 mm long; prickles present, 15–100 per flower, 1–6 mm long; stellate hairs very dense, white or transparent, 0.5–0.6 mm across, stalks 0–0.3 mm long, lateral rays 8–18, porrect, ascending or 2–3-tiered; central ray 1.0–1.5 times as long as laterals, not gland-tipped; simple hairs absent; short glandular hairs absent. Corolla purple, 9–18 mm long, rotate; outer surface with or without prickles, prickles 0–15; inner surface glabrous. Anthers 3.3–4.0 mm long; filaments 0.5–1.2 mm long; ovary with short glandular hairs only; functional style 7.5–10 mm long, erect or slightly off-centre near its base then recurved towards apex, glabrous or with short glandular hairs only. Fruiting calyx lobes more than half length of mature fruit or exceeding mature fruit, prickles 1–5 mm long. Mature fruits 1–3 per inflorescence, globular, 10–14 mm diameter, yellow or white, pericarp 1–2.5 mm thick, pedicels 2.5–8 mm long. **Figs. 1E–F, 2, 10, 12.**

*Distribution & habitat. Solanum pallidifolium* is found on a number of ranges and mountains in southern Northern Territory, south from Mt Leichhardt, in Western Australia eastwards from Warburton, and on the Birksgate, Mann and Everard Ranges of South Australia (Fig. 8). It grows on rocky slopes or in rock


**Fig. 13.** Representative specimen of ***Solanum petrophilum*** (*B.J. Blaylock 482*, AD).

crevices on granite inselbergs and outcrops, on quartzite mountaintops and ranges, and sometimes on sandy soils adjacent to these ranges. Altitudes are above 650 metres in S.A. and W.A., and above 900 metres in N.T. This species has a broad distribution on hills and mountains in central Australia, though apparently absent from the Musgrave Ranges.

*Notes. Solanum pallidifolium* is distinguished from other species in the complex by its short anthers and rather broad leaves with pale to silvery indumentum and 4–7 pairs of shallow lobes. The tomentum on the lower leaf midrib and the petiole is often floccose, and 2–3-tiered stellate hairs are present on both the lower and upper side of the leaves. Specimens from the Macdonnell Ranges frequently have fewer calyx prickles (15–40) per flower, while specimens from elsewhere have between 30 and 100 calyx prickles.

Incomplete specimens of *S. pallidifolium* are sometimes difficult to distinguish from *S. osteocarpum*, particularly those from around Ronald Bore in the Everard Ranges. *S. pallidifolium* has many 2–3-tiered stellate hairs on the underside of the leaves, rachises and calyces, while *S. osteocarpum* has few or none. In addition, *S. pallidifolium* has an ovate to broadly ovate lamina, a shorter style and shorter anthers.

*Etymology*. The epithet is from the Latin *pallidus* (pale) and *folius* (leaf), and refers to the conspicuously grey or even silvery appearance of the leaves of this species.

*Specimens examined:*

Western Australia: Petermann Ra., W of N.T.-W.A. border, 22 Sep. 1978, *A.C. Beauglehole 60530 & E.G. Errey 4230* (PERTH); Base of Schwerin Mural Crescent near Gill Pinnacle, 17 June 1977, *A.A. Burbidge 49/77 & P.J. Fuller* (PERTH); Just S of Camp 1 at Townsend Ridges, 42 km SE of Warburton, 6 May 2000, *D.J. Edinger 1891 et al.* (PERTH); Camp 2, N Jameson Ra., 113 km ENE of Warburton, 30 Apr. 2001, *D.J. Edinger 2335* (PERTH); Cavenagh Ra., 7 July 1963, *A.S. George 4773* (PERTH); Pass of the Abencerrages, Rawlinson Ra., 9 July 1963, *A.S. George 4914* (PERTH); c. 3 miles [5 km] W of Blackstone Mining Camp, Blackstone Ra., E section, 11 July 1958, *R. Hill & T.R. Lothian 923* (DNA).

Northern Territory: Mt Leichhardt, upper S slope, 25 Aug. 2005, *D.E. Albrecht 11681 & P.K. Latz* (NT); Garden of Eden, 50 metres from main pool, Watarrka N.P., 24 Aug. 2002, *J.S. Barnetson 131* (NT); Petermann Ra., 22 Sep. 1978, *A.C. Beauglehole 60712 & E.G. Errey 4412* (DNA); Trephina Gorge, c. 50 miles E of Alice Springs, 5 Aug. 1957, *G. Chippendale 3585* (NT); Mt Cockburn, 17 Jan. 1972, *N. Henry 373* (DNA); Mann Ra., 31 miles [50 km] ENE of Mt Davies camp, 25 59'S 129 40'E, 31 Oct. 1970, *P.K. Latz 896* (DNA); 6 miles [10 km] SW of Mt Liebig bore, 6 Apr. 1972, *P.K. Latz 2286* (DNA); Dean Ra., 26 Aug. 1973, *P.K. Latz 4189* (DNA); Pulca Carrinya rockhole, Mt Wedge Stn, 3 Sep. 1976, *P.K. Latz 6602* (AD, DNA, NT); Spencer Gorge, Chewings Ra., 26 May 1977, *P.K. Latz 7110* (DNA); Mt Gurner, 48 km W of Newhaven Hmsd, 9 June 2002, *P.K. Latz 18677* (NT); Pulca Carrinya waterhole, central Mt Wedge area, 26 Apr. 1988, *G. Leach 1880 & M. Barret* (DNA); Standley Chasm, c. 49 km W of Alice Springs, 14 July 1968, *A.E. Orchard 838* (AD, NT); Gill Ck, Mt Winter, 27 Apr. 1987, *B.G. Thomson 1678* (DNA, NT); Chewings Ra., 27 Feb. 1990, *B.G. Thomson 3419* (DNA, NT).

South Australia: Ronald Well area, Everard Ra., Everard Park, 25 June 1965, *A.C. Beauglehole 10182* (AD); 5 km S of Victory Well on road to Teeta Bore, Everard Ra., 7 Sep. 1985, *P.D. Canty 1294* (AD); 3.5 km W from Ronald Bore, 22 Mar. 1993, *P.D. Canty & J.S. Gillen BS23-21286* (AD); 5.6 km W (271 deg.) from Mt Hoare, 23 Sep. 2001, *P.D. Canty BS23-38957* (AD); Camp 15, [Near Mt Watson, Birksgate Ra.], 6 July 1891, *R. Helms s.n.* (AD); Mt Lindsay, at base of SE side, Birksgate Ra., 29 Aug. 1980, *P. Horton 210* (AD); 1.8 km SW from Mt Lindsay, 3.2 km direct NNE of Mt Holder, 18 Oct. 1996, *P.J. Lang & P.D. Canty BS23-26593* (AD); 0.5 km direct NNW of Wartaru, 19 Oct. 1996, *P.J. Lang et al. BS23-26673* (AD); Mt Illillinna, APY Lands, 0.9 km direct ENE of Mt Illillinna, 13 June 1997, *D.E. Murfet BS23 27433* (AD); Above Watarunya Rockhole, head of the valley on S side of Mt Lindsay, 30 Aug. 1978, *K. Stove 307* (AD); 4 miles NW of Everard Park, 17 June 1953, *D.E. Symon s.n.* (AD 98571318); Mt Lindsay, 6 Aug. 1962, *D.E. Symon 2551* (AD); c. 1.45 km WNW of summit of Mt Poondinna rockhole, 29 Aug. 1978, *D.J. Whibley 6422* (AD); SE slopes of large hill, c. 2.5 km direct NW of summit of Mt Poondinna, 29 Aug. 1978, *D.J. Whibley 6480* (AD); Mt Moulden, E facing slopes towards the base, 1 Sep. 1978, *D.J. Whibley 6666* (AD).

***Solanum petrophilum* F.Muell.**

Linnaea 25: 433 (1853). **Type:** South Australia: Near Cudnaka [Kanyaka], October 1851, *F. Mueller s.n.* (lecto: MEL 12107, here designated; isolecto: MEL12106).

*Illustration:* Symon (1981: 215).

Sprawling or erect rhizomatous perennial shrub, 0.2–0.6 m high. *Branchlets* terete, yellow, rusty or brown; prickles 2–12 per cm, straight and acicular, 6–18 mm long, 0.6–1 mm wide at base, 8–20 times longer than wide, glabrous; hairs stellate; stellate hairs very dense, 0.4–0.55 mm diameter, stalks 0–0.1 mm long, lateral rays 7–8, porrect or ascending, central ray 0.5–1.1 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; short glandular hairs absent. *Leaves* elliptical or ovate, 2.3–8.1 cm long, 1.3–4.1 cm wide, 1.6–3.0 times longer than broad, shallowly or deeply lobed throughout; lobes 2–5 on each side, obtuse, lobing index 1.5–2.3; apex obtuse, base cuneate or obtuse or cordate, oblique part 0–7 mm long, obliqueness index 0–10 percent; petioles 0.6–2.4 cm long, 15–37 % length of lamina, prickles present, indumentum not floccose. *Upper leaf surface* green or grey-green; prickles present on midvein only or on midvein and lateral veins, 2–9, straight and acicular, 3–16 mm long; stellate hairs distributed throughout, sparse to moderately dense, 0.25–0.6 mm apart, 0.4–0.65 mm across, stalks 0–0.1 mm long; lateral rays 6–8, porrect; central ray 0.5–1.0 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. *Lower leaf surface* greenish-white to grey, or yellow to rusty; prickles present on midvein only or present on midvein and lateral veins, 2–18, straight and acicular. Lower leaf surface stellate hairs dense to very dense, not floccose, 0.1–0.25 mm apart, 0.4–0.65 mm diameter, stalks 0–0.1 mm long; lateral rays 7–8, porrect; central ray 0.5–1.1 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. *Inflorescence* leaf opposed or supra-axillary, cymose (pseudo-racemose), common peduncle 7–17 mm long, rachis prickles absent or present,3–5 (–7)-flowered, with all flowers bisexual; flowers 5-merous; pedicels at anthesis 3.5–10 mm long, same thickness throughout, prickles absent or present. Calyx tube at anthesis 2.5–3.5 mm long; lobes attenuate, 5–10 mm long; prickles present, 10–35 per flower, 3–8 mm long; stellate hairs dense to very dense, white, rusty or transparent, 0.4–0.5 mm across, stalks 0–0.15 mm long, lateral rays 7–8, central ray 0.5–1 times as long as laterals, not gland-tipped, 2–3-tiered hairs absent; simple hairs absent; short glandular hairs absent. Corolla purple, 14–20 mm long, rotate; outer surface without prickles; inner surface glabrous. Anthers 3.8–6.0 mm long; filaments 1–2.2 mm long; ovary glabrous or with short glandular hairs only; functional style 7.5–10.5 mm long, strongly bent near its base and then recurved towards apex, glabrous or with short glandular hairs only. Fruiting calyx lobes more than half length of mature fruit or exceeding mature fruit, prickles 3–5 mm long. Mature fruits 1–3 per inflorescence, globular, 13–15 mm diameter, yellow or white, pericarp 1–1.5 mm thick, pedicels 7–10 mm long. **Figs. 1B, 13.**

*Distribution & habitat. Solanum petrophilum* is widespread in central and eastern parts of South Australia, including the Gawler Ranges, northern Eyre Peninsula, Flinders Ranges, the Olary district, and inland to Tarcoola and Marree. It also extends to the Broken Hill area of New South Wales, and there is a disjunct occurrence in the Goldfields region of Western Australia, eastward from Kalgoorlie (Fig. 14). It grows on a wide variety of sites, including creek-banks and plains, but usually on stony hills.

*Typification.* Symon (1981: 214) referred to two specimens at MEL that are original material, saying that MEL12107 "should perhaps be nominated holotype" of *S. petrophilum*. As there are two specimens, and no way of knowing whether two gathering are involved, the term holotype is inadvisable or incorrect, and under Article 9.9 (McNeill et al. 2012), Symon's use of the term "holotype" is correctable to "lectotype". However, Symon did not make a definitive statement, and it is doubtful whether his suggestion constitutes a valid lectotypification. Therefore I have here formally designated the specimen suggested by Symon (MEL 12107) as the lectotype of the name.

*Notes. Solanum petrophilum* sens. str. is highly variable, but is recognisable by the relatively few lobes on the leaves, the stout prickles 0.6–1 mm wide at the base, and the comparatively few (10–35) prickles on the calyces. Morphological differences exhibited between *S. petrophilum* specimens from the Gawler Ranges, Eyre Peninsula, Flinders Ranges, Goldfields of Western Australia, etc., are deemed too inconsistent and too minor to warrant taxonomic recognition.

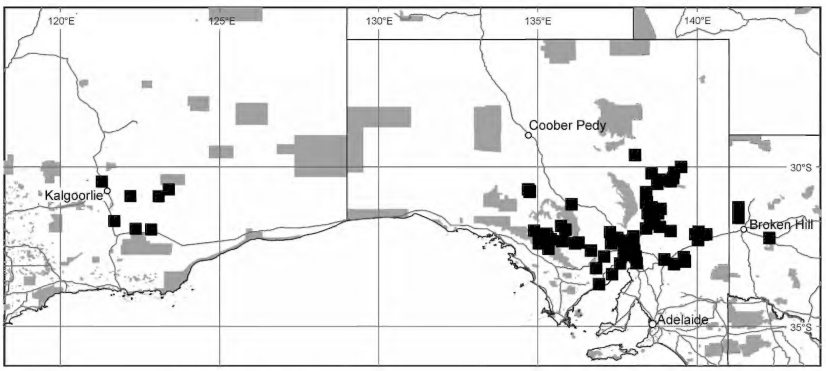


**Fig. 14.** Distribution of ***Solanum petrophilum***.

Specimens with sparse hairs on the upper leaf surface may be confused with *S. lobatum*, but the latter species has larger stellate hairs (0.6–1.1 mm diameter) on the upper leaf surface, usually a greater number of lobes per leaf, and many more prickles on the calyx. *S. petrophilum* is the only species of the complex that consistently lacks prickles on the corolla.

*Specimens examined:*

Western Australia: Bineronca Nature Res., N of Higginsville on a track E of the Norseman to Widgemooltha Rd, 2 July 2006, *G. Byrne 2166* (AD, PERTH); 32 miles [51 km] E of Karonie, trans-line, 9 Nov 1963, *A.S. George 5952* (PERTH); Buldania Rocks, c. 28 km by road ENE of Norseman, c. 200 m N of Eyre Hwy to Balladonia, 24 Sep. 1977, *E.N. Jackson 3484* (AD); 81 km WNW of Balladonia on road to Norseman, 13 Oct. 1994, *B.J. Lepschi & T.R. Lally 1667* (AD, BRI, CANB, PERTH).

South Australia: "Pine Hill Res.", Lincoln Hwy, Cowell to Whyalla Rd, N of Cowell, 22 Dec. 1965, *C.R. Alcock 877* (AD); Lincoln Hwy, between Pt Augusta and Whyalla, 11 Feb. 1967, *C.R. Alcock 1325* (AD); 11 km N of Thurlga Stn Hmsd, Gawler Ra., 8 Oct. 1972, *C.R. Alcock 4227* (AD); 13 km ESE of Tarcoola, Wilgena Stn, 5 Sep. 1995, *F.J. Badman 8438* (AD); Pualco Ra. and Levi Ra., 3 June 1989, *R. Bates 18574* (AD); 99 miles [160 km] SE of Lake Hart, on road 42 miles NW of Pt Augusta, 5 Oct. 1966, *A.C. Beauglehole 20002A* (AD); Hiltaba Stn, c. 2 km W of Hiltaba Hmsd, 6 Sep. 1972, *B.J. Blaylock 1959* (AD); 27 miles [43 km] from Iron Knob, towards Pt Augusta, 28 Aug. 1968, *E.M. Canning 2091* (CANB); 5.3 km direct WNW of Grindell Hut, Gammon Ra. N.P., 23 Nov. 1998, *P.D. Canty & T.J. Hudspith BS104-798* (AD); Mt Saint Mungo, 40 km NW of Yardea, 2 Oct. 1969, *J. Carrick 2397* (AD); Marree, 15 Sep. 1956, *J.B. Cleland s.n.* (AD); Oak Park c. 32 km S of Yunta, 2 Oct. 1971, *N.N. Donner 3719* (AD); Fire track along the top of The Battery, Mambray Ck, Mt Remarkable N.P., 6 Aug. 1974, *N.N. Donner 4884* (AD); Koondoolka, 19 June 1977, *N.N. Donner 5798* (AD); Environs of Loch Ness Well (upper Balcanoona Ck), Gammon Ra., 23 Sep. 1956, *Hj. Eichler 12899* (AD); Rd from Parachilna Gorge to Parachilna, 14 July 1955, *R. Hill 2* (AD); Warren Gorge,15 km NW of Quorn, 14 Oct. 1974, *V. Jaegermann 412* (AD); Grounds of Shoreline Caravan Park, Pt Augusta, 25 Sep. 2010, *R.A. McKenzie RAM10/147* (AD, BRI); NW end of Uno Ra., Uno Stn, 35 km W of Iron Knob, 10 Mar. 1981, *F. Mollenmans 47* (AD); Woman in White Mine area, Old Boolcoomata Stn, N of Olary, 11 Feb. 1968, *R.C. Nash s.n.* (AD 96825042); Near exit road to Iron Knob on Pt Augusta-Kimba road, 12 Sep. 1983, *R.D. Pearce 339* (AD, CANB, MO, L, US); 5.7 km direct SSW of Mt Fitton, Mt Freeling property, 18 Nov. 1998, *A.C. Robinson BS104-1245* (AD); near Tommie Wattie Bore, Outalpa Stn, 8 Oct. 1989, *A.G. Spooner 11744* (AD); About Aroona ruins, Aroona Valley, Oraparinna N.P., 18 Sep. 1971, *D.E. Symon 7522* (AD); Main road a little S of Pt Augusta and N of Mambray Ck, s.dat., *D.E. Symon 13932* (AD); Stuart Hwy, 74 km N of Pimba, 12 Jan. 2009, *D.E. Symon 17397 & J. Symon* (AD); Pichi Richi Pass at creek flat near Saltia, 11 Oct. 1959, *D.J. Whibley 528* (AD).

New South Wales: Mt Robe, 4 Sep. 1921, *A. Morris 697* (BRI); Big Cave Ck, Mootwingee Historic Site, 86 miles (138 km) NE of Broken Hill, 28 Oct. 1972, *A.J. Sikkes & I.R. Telford 289* (AD).

## Acknowledgements

I am grateful to the Directors of CANB, DNA, PERTH, NT and AD for sending specimens on loan. I thank Will Smith (BRI) for the illustrations and specimen images, and Gordon Guymer for reviewing an earlier draft.

## References

Barker, R.M. (2010). *Solanum petrophilum*. In: *Australian Solanaceae species: identification and information*, Ver. 1. www.flora.sa.gov.au/efsa/lucid/Solanaceae/Solanum%20species/key/Australian%20Solanum%20species/Media/Html/Solanum_petrophilum.htm [accessed: 20 Aug. 2015].

Bean, A.R. (2004). The taxonomy and ecology of *Solanum* subg. *Leptostemonum* (Dunal) Bitter (Solanaceae) in Queensland and far north-eastern New South Wales. *Austrobaileya* 6: 639–816.

Black, J.M. (1926). *Flora of South Australia*, Part 3. (Government Printer: Adelaide).

McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersema, J.H. & Turland, N.J. (2012). *International Code of Nomenclature for algae, fungi and plants (Melbourne Code)*. (Koeltz: Königstein). www.iapt-taxon.org/nomen/main.php?page=title [accessed: 4 July 2015].

Mueller, F. (1853). Diagnoses et descriptiones plantarum novarum, quas in Nova Hollandia australi praecipue in regionibus interioribus. *Linnaea* 25: 367–445.

Roe, K.E. (1971). Terminology of hairs in the genus *Solanum*. *Taxon* 20(4): 501–508.

Symon, D.E. (1981). A revision of the genus *Solanum* in Australia. *Journal of the Adelaide Botanic Gardens* 4: 1–367.

Whalen, M.D. (1984). Conspectus of species groups in *Solanum* subgenus *Leptostemonum*. *Gentes Herbarum* 12: 179–282.

*Journal of the Adelaide Botanic Gardens* 29 (2016) 37–40


# *Thelidium robustum* sp. nov. (lichenized Ascomycota, Verrucariaceae) from Kangaroo Island, South Australia

*Patrick M. McCarthy*[a] *& Gintaras Kantvilas*[b]

[a] 64 Broadsmith St, Scullin, Australian Capital Territory 2614
*Email*: pmcc2614@hotmail.com

[b] Tasmanian Herbarium, PO Box 5058, UTAS LPO, Sandy Bay, Tasmania 7005
*Email*: Gintaras.Kantvilas@tmag.tas.gov.au

## Abstract

*Thelidium robustum* P.M.McCarthy & Kantvilas sp. nov. (Verrucariaceae) is described from coastal limestone on Kangaroo Island, South Australia. It is characterized by a grey to dark greyish green, ecorticate, crustose-areolate to pseudosquamulose thallus that is attached to the substratum by hyaline rhizohyphae. The new species is distinguished from other calcicolous taxa of *Thelidium* principally by its comparatively robust thalline morphology in combination with immersed to superficial, simple perithecia and 1-septate ascospores of (16–) 22 (–26) × (9–) 11 (–13) µm. A key is provided to five species of *Thelidium* known from Australia. *Verrucaria papillosa* Ach. (Verrucariaceae) is reported for the first time from South Australia.

**Keywords:** *Thelidium*, Verrucariaceae, lichens, new species, South Australia

## Introduction

*Thelidium* A. Massal. (Verrucariaceae, Verrucariales) grows almost exclusively on calcareous and siliceous rocks in aquatic, semi-aquatic and terrestrial habitats, with approximately 100 species known mainly from northern-temperate to boreal latitudes (Zschacke 1933; Servít 1954; Kopachevskaya et al. 1977; Clauzade & Roux 1985; McCarthy 2001; Galloway 2007; Thüs & Nascimbene 2008; Orange 2009; Thüs & Schultz 2009). The thallus is crustose, usually ecorticate and immersed in the substratum to partially superficial and diffuse, continuous or areolate. Ascomata are perithecioid, immersed in the thallus or directly in the substratum, or semi-immersed to superficial, with or without a dark to black involucrellum, and the asci are fissitunicate, each producing eight colourless, thin-walled ascospores with 1–3 (–7) transverse septa, occasionally with 1–3 longitudinal or oblique divisions. Traditionally, ascospore septation has distinguished *Thelidium* from the simple-spored *Verrucaria* Schrad., while it remains poorly differentiated from *Polyblastia* sens. lat. in which ascospores are submuriform to fully muriform and range from colourless to dark brown. However, molecular studies have shown ascospore septation to be an unreliable diagnostic character among the crustose genera of Verrucariales (Guedian et al. 2007), with a suggestion, as yet unconfirmed, that groups of species currently in *Thelidium* might eventually be segregated as distinct genera (Thüs & Nascimbene 2008).

In this paper, we describe *T. robustum*, a new species from limestone on Kangaroo Island, South Australia. It is characterized by an exceptionally well-developed, grey to dark green, crustose-areolate to pseudosquamulose thallus that is anchored by hyaline rhizohyphae, as well as comparatively small, non-involucrellate perithecia producing 1-septate ascospores of moderate size. Among the lichens associated with the new species is *Verrucaria papillosa* Ach. which is reported here for the first time from South Australia. We also provide a key to the five known Australian species of *Thelidium*.

## Methods

Observations and measurements of thallus and ascomatal anatomy, asci and ascospores were made on hand-cut sections mounted in water and dilute KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K.

## Taxonomy

***Thelidium robustum* P.M.McCarthy & Kantvilas, *sp. nov.***

*Thallus calcicola, crustosus aut minute pseudosquamulosus, pallide griseus vel viridiater, 80–300 µm crassus. Pseudosquamulae rotundatae aut elongatae, (0.2–) 0.6 (–1.2) × (0.2–) 0.45 (–0.8) mm, rhizohyphis hyalinis substrato affixae. Algae chlorococcoideae, 8–12 (–14) µm diametro. Perithecia globosa vel pyriformes, immersa aut prominentia, (0.17–) 0.25 (–0.31) mm diametro. Involucrellum destitutum. Excipulum bistratum, superne 40–70 µm crassum, inferne 18–25 (–30) µm, externe fuscoatrum et 8–30 µm crassum, interne pallide vel mediofuscum et 10–40 µm. Paraphyses destitutae. Periphyses simplices, 12–20 × 2–3 (–4) µm. Asci fissitunicati, late clavati, 70–85 × 24–30 µm. Ascosporae incoloratae, 1-septatae, plerumque anguste ellipsoideae, (16–) 22 (–26) × (9–) 11 (–13) µm.*

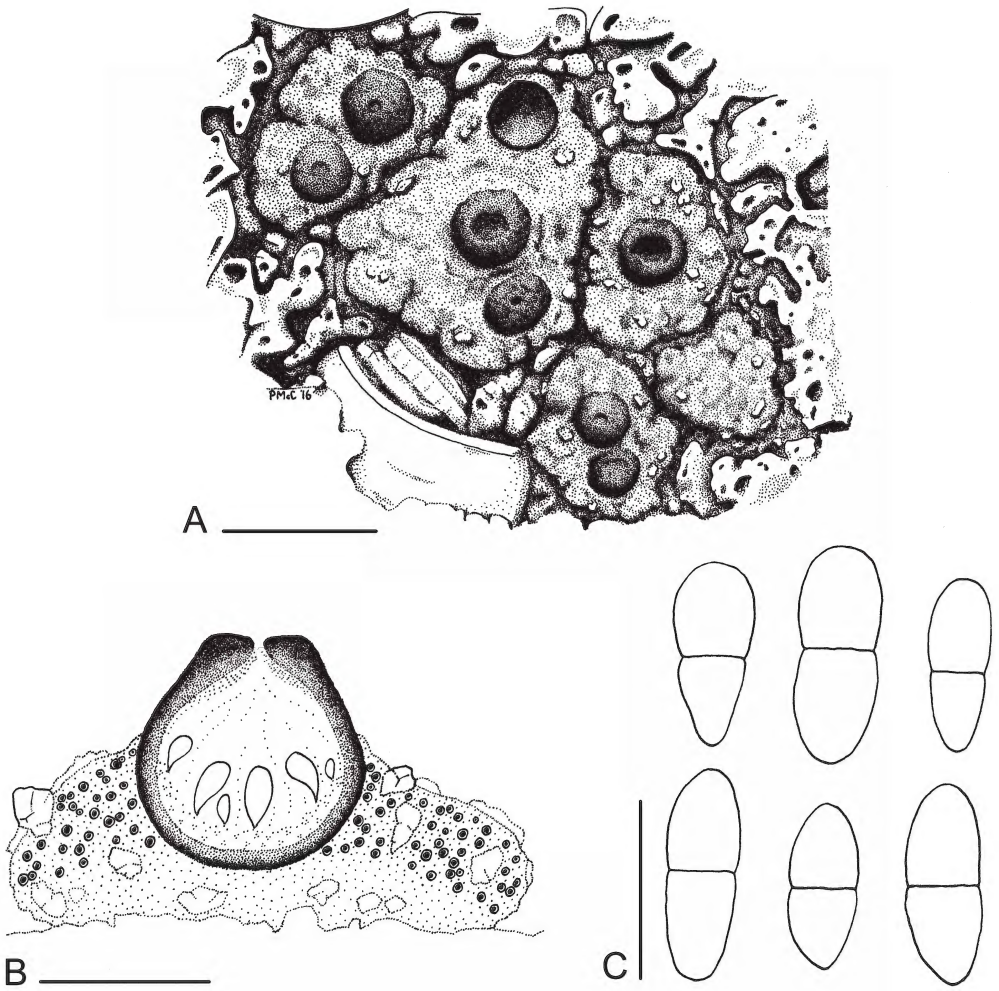


**Fig. 1.** ***Thelidium robustum.*** **A** habit of a fertile thallus; **B** sectioned perithecium and adjacent thallus (semi-schematic); **C** mature ascospores. Scale bars: **A** 0.5 mm; **B** 0.2 mm; **C** 20 µm. — **A–C** holotype.

**MycoBank No.:** MB816611.
**Holotype:** South Australia: Kangaroo Island: c. 1.5 km SW of Point Ellen, 36°00'S, 137°11'E, alt. 10 m, on calcarenitic limestone in coastal heathland, 22 Sep. 2015, *G. Kantvilas 444/15* (HO 581507).

Thallus saxicolous on calcarenitic limestone, diffuse and with scattered microthalli in fissures and pits in the substratum, not forming substantial, continuous colonies, dull and pale to medium grey or greyish green or dark green, initially crustose and areolate, becoming pseudosquamulose (i.e. the outwardly squamulose habit at maturity is derived from crustose thallus initials, and the medulla and algal layer are impregnated with minute rock fragments and crystals, thus closely resembling hemiendolithic crusts), 80–300 µm thick, the surface ± smooth to minutely uneven and irregularly rugulose, with rock fragments commonly protruding, ecorticate, but with a continuous or patchy, hyaline, necral layer c. 10 µm thick which can give the impression of an uneven greyish pruina in surface view; pseudosquamules ± isodiametric and rounded to angular, or irregular to elongate, entire or with a minutely lobate-effigurate margin, (0.2–) 0.6 (–1.2) × (0.2–) 0.45 (–0.8) mm [$n$ = 50], attached to the substratum by 3–5 µm thick, hyaline rhizohyphae; rhizines absent. Photobiont cells green, unicellular, chlorococcoid, 8–12 (–14) µm diam., not clustered but scattered throughout thinner thalli, or forming a layer 50–120 µm thick below the surface of

thicker pseudosquamules. Medulla nondescript or 50–120 (–150) µm thick, heavily impregnated with minute rock fragments and crystals (as is the algal layer); cells angular to rounded-irregular, paraplectenchymatous, 5–8 µm wide. Prothallus absent; hypothallus not apparent. Ascomata perithecia, numerous, solitary, usually scattered, (0.17–) 0.25 (–0.31) mm diam. [*n* = 70], 1–3 (–5) per pseudosquamule, outwardly dull blackish, almost completely immersed to semi-immersed in thicker pseudosquamules to almost superficial on thinner, crustose thalli, subglobose to broadly pyriform, not overgrown by the thallus; perithecial apex initially plane, later concave, the ostiole central in a shallow, 60–100 µm wide depression; apices of post-mature ascomata commonly deeply excavate. Involucrellum absent. Excipulum 40–70 µm thick at the apex, 18–25 (–30) µm thick at the sides and base, bilayered throughout (thin section), K–; outer layer dark olive-brown, 8–30 µm thick, the cells rounded-angular, 5–7 µm wide, comparatively thick-walled; inner layer pale to medium brown, 10–40 µm thick, the cells periclinally elongate, 6–10 × 3–4 µm, thin-walled and closely arranged. Subhymenium 20–30 µm thick. Paraphyses absent. Periphyses unbranched, 12–20 × 2–3(–4) µm. Hymenium IKI+ dark orange-brown. Asci fissitunicate, 8-spored, broadly clavate, 70–85 × 24–30 µm [*n* = 15]; wall thickened at the apex; ocular chamber not apparent. Ascospores irregularly arranged in the ascus, colourless, 1-septate, narrowly ellipsoid to oblong-fusiform, straight, with a median or, occasionally, submedian septum and rounded or subacute ends, not or only slightly constricted at the septum, (16–) 22 (–26) × (9–) 11 (–13) µm [*n* = 40]; wall 0.8–1.5 µm thick, to 2 µm thick at the septum, lacking an epispore; contents clear to minutely granulose. Pycnidia absent. **Fig. 1**.

*Etymology.* The epithet *robustum* refers to the comparatively stout thalline morphology of the new species.

*Remarks. Thelidium robustum* is characterized by having ecorticate pseudosquamules that are attached to the substratum by hyaline rhizohyphae, small, often prominent, blackish perithecia with a dark, bilayered excipulum and lacking an involucrellum, combined with moderately large, 1-septate ascospores. For the purposes of comparison with broadly similar taxa, once exclusively aquatic and/or silicolous taxa are excluded from consideration, as well as those with a predominantly endolithic thallus or involucrellate perithecia, species producing significantly smaller or larger, 1-septate ascospores, and those with propagules having 3 or more septa, very few remain. Thus, the common, northern-temperate to boreal *T. minutulum* Körb. has perithecia and ascospores of similar dimensions to those of the South Australian lichen. However, this is an unambiguously crustose species with a continuous, rimose or granular thallus that rarely exceeds 150 µm in thickness, it has clustered algal cells 4–9 µm wide and a perithecial excipulum that is considerably thinner towards the apex and colourless in its basal half (Thüs & Nascimbene 2008; Orange 2009; Thüs & Schultz 2009). *Thelidium rehmii* Zschacke, from moist sandstone in central Europe and Great Britain and sometimes very similar to *T. minutulum*, has paler and even thinner thalli with scattered algal cells, but the excipulum is colourless towards the base, and ascospores are 20–30 µm long (Thüs & Nascimbene 2008; Thüs & Schultz 2009). Finally, *T. calcareum* (Muell.Arg.) Hellb., which appears to be endemic to New Zealand, has a very thin, dark olive to blackish brown, effuse or abraded thallus and ascospores 14–18 µm long (Galloway 1985, 2007).

The generic position of the new species is a little ambiguous insofar as the thallus is initially crustose and areolate, and it either maintains that morphology or becomes pseudosquamulose at maturity, being attached to the substratum by hyaline rhizohyphae. Such thalli might suggest a more appropriate placement in *Placidiopsis* Beltr., an almost exclusively Northern Hemisphere genus of temperate to boreal latitudes and arid or semi-arid regions (Breuss 1996). However, the outwardly squamulose morphology at maturity is derived from crustose thallus initials, and the medulla and algal layer are impregnated with minute rock fragments and crystals, a feature typical of hemiendolithic Verrucariaceae (such as *Thelidium*) and not of taxa in which squamules develop on the substratum (e.g. *Placidiopsis*). Indeed, it can also be argued convincingly that separating genera of Verrucariaceae solely on thallus morphology (crustose and areolate as opposed to squamulose) is artificial and requires additional supporting characters, such as molecular data. Those data are beyond the scope of the present morphological study, and our principal purpose is to bring a clearly unusual and novel taxon from a remote, relatively rarely studied area to the attention of lichenologists and land managers.

Molecular studies of *T. robustum*, perhaps in conjunction with additional, more informative collections, and leading to a transfer to *Placidiopsis*, would not diminish the integrity of the Australian lichen, as the five known saxicolous species of *Placidiopsis* are certainly distinct from *T. robustum*. Thus, the Brazilian *P. hypothallina* Aptroot (Aptroot 2002), *P. porinoides* Aptroot from China (Aptroot & Seaward 1999) and *P. minor* R.C.Harris from eastern U.S.A. and Greenland (Harris 1979; Alstrup 1991; Breuss 1996) have diminutive perithecia up to 0.1 mm in diameter and ascospores 8–13 µm long. Two other species, *P. sbarbaronis* (Servít) Clauzade & Cl.Roux from Italy and *P. cavicola* Etayo & Breuss from Spain, have perithecia of broadly similar size to those of the Australian lichen. However, the former has perithecia with an apical involucrellum (Servít 1953; Clauzade & Roux 1985), while *P. cavicola* has a hyaline excipulum and ascospores of 13–17 × 6–7 µm (Etayo & Breuss 1994; Prieto et al. 2010).

*Distribution & habitat.* The new species is known only from calcarenitic limestone at the type locality, near Point Ellen on the south coast of Kangaroo Island, South Australia. The site is in coastal heathland, just a few hundred metres from the shoreline, where the *Thelidium* grew on exposed, low, undulating bedrock in gaps amongst the dense shrubbery. Associated lichens on the rocks included *Circinaria contorta* (Hoffm.) A.Nordin, S.Savic & Tibell, *Sarcogyne meridionalis* P.M.McCarthy & Kantvilas, *Sarcogyne* sp., *Toninia australis* Timdal and *Verrucaria papillosa* Ach., the last a new record for South Australia (*G.Kantvilas 445/15*; HO 581508). The substratum is very coarse and crumbly, with the composite shell and sand fragments readily discernible, and is of early Pleistocene origin (Milnes et al. 1983). The general vegetation and geology of the site (heathland on shallow, sandy soils over limestone) is widespread along the southern coast of Kangaroo Island, the southern mainland of Australia and, to a lesser extent, on Flinders Island. Lichen distribution is patchy in such places, with the soil generally unstable, the shrubbery dense and sand-blasted by wind, and much of the rock surface easily eroded.

## Acknowledgement

We are grateful to an anonymous referee for advice on the generic placement of *T. robustum*.

## References

Alstrup, V. (1991). Variation in *Placidiopsis minor* as shown by a specimen from Greenland. *Lichenologist* 23: 89–91.

Aptroot, A. (2002). New and interesting lichens and lichenicolous fungi in Brazil. *Fungal Diversity* 9: 15–45.

Aptroot, A. & Seaward, M.R.D. (1999). Annotated checklist of Hong Kong lichens. *Tropical Bryology* 17: 57–101.

Breuss, O. (1996). Revision der Flechtengattung *Placidiopsis* (Verrucariaceae). *Österreichische Zeitschrift für Pilzkunde* 5: 65–94.

Clauzade, G. & Roux, C. (1985). Likenoj de okcidenta Eŭropo. Ilustrita determinlibro. *Bulletin de la Société Botanique du Centre-Ouest*, Nouvelle Série, Numéro Spécial **7**: 1–893.

Etayo, J. & Breuss, O. (1994). *Placidiopsis cavicola*, a new lichen species (Verrucariaceae) from the Pyrenees. *Österreichische Zeitschrift für Pilzkunde* 3: 21–24.

Galloway, D.J. (1985). *Flora of New Zealand lichens*. (P.D. Hasselberg: Wellington).

Galloway, D.J. (2007). *Flora of New Zealand lichens*. Revised second edition. Vol. 2. (Manaaki Whenua Press: Lincoln).

Gueidan, C., Roux, C. & Lutzoni, F. (2007). Using a multigene phylogenetic analysis to assess generic delineation and character evolution in Verrucariaceae (Verrucariales, Ascomycota). *Mycological Research* 111: 1145–1168.

Harris, R.C. (1979). The genus *Placidiopsis* Beltr. (lichenized ascomycetes) new to North America as *Placidiopsis minor* sp. nov. *Michigan Botanist* 18: 57–58.

Kopachevskaya, E.G., Makarevicz, M.F. & Oxner, A.N. (1977). *Opredelidetel' lishainikov SSSR.* Vol. 4. *Verrucariaceae-Pilocarpaceae*. (Nauka: Leningrad).

McCarthy, P.M. (2001). *Thelidium*. *Flora of Australia* 58A: 174–175.

McCarthy, P.M. (2014). Additional lichen records from Australia 77. Verrucariaceae. *Australasian Lichenology* 75: 3–5.

Milnes, A.R., Ludbrook, N.H., Lindsay, J.M. & Cooper, B.J. (1983). The succession of Cainozoic marine sediments on Kangaroo Island, South Australia. *Transactions of the Royal Society of South Australia* 107: 1–35.

Orange, A. (2009). *Thelidium* A.Massal. (1855). In: Smith, C.W., Aptroot, A., Coppins, B.J., Fletcher, A., Gilbert, O.L., James, P.W. & Wolseley, P.A. (eds), *The lichens of Great Britain and Ireland*, pp. 931–957. (British Lichen Society: London).

Prieto, M., Martínez, I. & Aragón, G. (2010). The genus *Placidiopsis* in the Iberian Peninsula and the Balearic Islands. *Mycotaxon* 114: 463–472.

Servít, M. (1953). Novae lichenum Pyrenocarporum species in Italia inventae (III). *Annali del Museo Civico di Storia Naturale Giacomo Doria* 66: 236–249.

Servít, M. (1954). *Československé lišejníky čeledi Verrucariaceae*. (Akademie Věd: Prague).

Thüs, H. & Nascimbene, J. (2008). Contributions toward a new taxonomy of Central European freshwater species of the lichen genus *Thelidium* (Verrucariales, Ascomycota). *Lichenologist* 40: 499–521.

Thüs, H. & Schultz, M. (2009). *Süßwasserflora von Mitteleuropa/Freshwater flora of Central Europe*, Vol. 21(1): *Fungi; Lichens*. (Springer Spektrum Akademischer Verlag: Heidelberg).

Zschacke, H. (1933). Epigloeaceae, Verrucariaceae und Dermatocarpaceae. *Dr. L. Rabenhorst's Kryptogammen-Flora von Deutschland, Österreich und der Schweiz* 9, 1(1): 44–695. (Akademische Verlagsgesellschaft: Leipzig).

**Key to *Thelidium* in Australia** (after McCarthy 2001, 2014)

**1.** Ascospores 3 (–4)-septate, 30–60 × 14–22 µm; perithecia prominent, involucrellate, 0.3–0.75 mm diam. [N.S.W., Tas., Vic.] . . . . . ***T. papulare*** (Fr.) Arnold

**1:** Ascospores 1-septate

**2.** Thallus semi-aquatic; perithecia prominent, 0.24–0.41 mm diam., the involucrellum partly overgrown by the thallus; ascospores 21–31 × 12–16 µm [Tas.] . . . . . ***T. pluvium*** Orange

**2:** Thallus growing on terrestrial rocks; perithecia with or without an involucrellum

**3.** Perithecia with a thin involucrellum that is contiguous with the hyaline to pale brown excipulum; thallus rimose to areolate, dark olive-brown, 20–50 µm thick [Vic.] . . . . . ***T. olivaceum*** (Fr.) Körb.

**3:** Perithecia lacking an involucrellum; thallus endolithic or epilithic, 80–300 µm thick

**4.** Thallus endolithic, inconspicuous; perithecia immersed in pits in the rock, 0.25–0.45 mm diam.; ascospores 25–40 × 10–17 µm [N.S.W.] . . . . . ***T. decipiens*** (Hepp) Kremp.

**4:** Thallus epilithic, areolate to pseudosquamulose; perithecia immersed in or superficial on the thallus, 0.17–0.31 mm diam.; ascospores 16–26 × 9–13 µm [S.A.] . . . . . ***T. robustum***

*Journal of the Adelaide Botanic Gardens* 29 (2016) 41–51


# *Entoloma ravinense* (Agaricales, Basidiomycota), a new species from South Australia

*Pamela S. Catcheside*[a,b], *Helen P. Vonow*[a] & *David E.A. Catcheside*[b]

[a] State Herbarium of South Australia, G.P.O. Box 1047, Adelaide, South Australia 5001
*Email*: pam.catcheside@sa.gov.au, helen.vonow@sa.gov.au

[b] School of Biological Sciences, Flinders University, P.O. Box 2100, Adelaide, South Australia 5001
*Email*: david.catcheside@flinders.edu.au

## Abstract.

*Entoloma ravinense*, a new species of *Entoloma* subgenus *Claudopus*, section *Claudopus*, is described. The species differs from other white laterally attached (pleurotoid) species of *Entoloma* in its larger fruit bodies, close lamellae, and larger basidia, and has internal transcribed spacer (ITS) and nuclear ribosomal RNA large subunit (28S) sequences that differ from all those available for other species of the genus. Descriptions and illustrations of *E. ravinense* are presented and comparisons made with other pleurotoid taxa in the subgenus. A key to Australian species of pleurotoid entolomas is provided.

**Key words**: *Entoloma*, subgenus *Claudopus*, section *Claudopus*, pleurotoid habit, wet sclerophyll habitat, Kangaroo Island, South Australia.

## Introduction.

The genus *Entoloma* (Fr.) P.Kumm. is represented by at least 1000 species worldwide (Kirk et al. 2008) and has been shown to be monophyletic (Matheny et al. 2006; Co-David et al. 2009). The subgenus *Claudopus* Gillet is considered to be an independent genus by some researchers (Horak 1980, 2008; Largent et al. 2011; Pegler 1986). Others (Noordeloos 1981, 1992, 2004, 2012; Manimohan et al. 2006) consider that the largely pleurotoid habit does not provide justification for the generic rank since there are pleurotoid taxa within other clades such as the *Inocephalus-cyanula* clade (Noordeloos & Gates 2012). Although *Entoloma* is a very large and morphologically variable genus, maintaining it as a single genus provides a stable classification that is consistent with phylogeny (Co-David et al. 2009). This paper follows the concept that *Claudopus* is a subgenus within the genus *Entoloma*.

Most species in the section *Claudopus* Noordel. are characterised by their pleurotoid habit with an initially central stipe that becomes excentric to lateral or disappears as the pileus expands (Noordeloos 1987, 1988, 2004, 2012). Some in that section are omphaloid, having a small stature and central stipe, but these will not be discussed in this paper.

The pleurotoid entolomas are often overlooked, in part due to often occurring in cryptic places, such as the underside of rocks, and their usually small size. Most are saprotrophic, growing on dead, often rotten wood and bark, on debris of grasses and sedges, on the ground or on mosses, but occasionally they are parasitic on fungi, such as species of *Cantharellus* Adans. ex Fr.

Species in the subgenus *Claudopus* are considered to be rare, the number currently amounting to no more than approximately 25. Noordeloos (2004) reported ten species from Europe, Horak (1980) reported five from Indomalaya and Australia and *Claudopus byssisedus* (Pers.:Fr.) Gillet (syn. *Entoloma byssisedum* (Pers.:Fr.) Donk) from New Zealand. Previous to 2011, authentic Australian material existed only for *Entoloma byssisedum* (May & Wood 1997). Since then, three saxicolous species have been described, *Claudopus rupestris* Largent & Abell-Davis, *C. viscosus* Largent & Abell-Davis, *C. minutoincanus* Largent & Abell-Davis (Largent et al. 2011) and *Entoloma pitereka* Noord. & G.M.Gates from Tasmania, growing on the underside of rotten wood in wet eucalypt forest (Noordeloos & Gates 2012).

The Ravine des Casoars Wilderness Protection Area, Kangaroo Island, where the fungus reported in this paper was found, is a steep sided valley vegetated by *Eucalyptus cladocalyx* F.Muell. and *E. diversifolia* Bonpl. sclerophyll forest. The area was burnt during severe bushfires in December 2007. The vegetation is now regenerating and the area is densely covered with *Acacia paradox*a DC. In both June 2010 and June 2014, fruit bodies were collected growing on the underside of shed bark of *E. cladocalyx*. In 2010 a dozen fruit bodies were found, scattered over bark measuring approximately 15 × 10 cm (Figs. 1 & 2); in 2014 only three fruit bodies were found, again on a similar sized piece of bark. The area was searched thoroughly but no further fruit bodies were found. A further collection of seven fruit bodies was made in 2015, again on very rotten shed *E. cladocalyx* bark.

**Fig. 1.** Fruit bodies of the holotype of ***Entoloma ravinense*** in situ. — Photo: D.E.A. Catcheside, 24 June 2010.

**Fig. 2.** Mature fruit bodies of the holotype of ***Entoloma ravinense*** in situ. — Photo: D.E.A. Catcheside, 24 June 2010.

The *Entoloma* species found on 24 June 2010 (*PSC 3331*, AD-C 56995) was the millionth specimen to be accessioned into the State Herbarium of South Australia (AD) and is therefore of considerable significance to that herbarium.

## Materials and Methods

### Morphology

Habitat and associated plant communities were noted in the field. Collection locations were recorded by GPS (Garmin GPS12) and in situ photographs and micrographs taken using a Nikon 4500 camera. Macroscopic characters were described directly from fresh material. Colours are described in general terms and more precisely according to Kornerup & Wanscher (1978) (page number, column letter, row number, e.g. 2B4). Fresh material was dried in a food dehydrator at 35°C for 24 h (Hydraflo 1000FD).

The number of lamellae per fruit body is given as L. Hand-cut sections of fresh and dried material were mounted in 5% aqueous solution of KOH, then stained with ammoniacal Congo Red. To determine the amyloid reaction, fresh material was directly stained with Melzer's reagent, dried material was rehydrated in 5% ammonium hydroxide before staining with Melzer's reagent. Measurements were made at ×400 or ×1000 with a calibrated ocular micrometer. Spore dimensions are given as length range × width range (n = 40). The length:width ratio (Q) of individual spores is presented as the range of Q values and the mean Q. Measurements do not include the apiculus. Basidia dimensions are given as length range × width range (n = 20). Illustrations and descriptions are in terms of structures visible by light microscopy. All macro- and microphotographs are from the type material *PSC3331*, AD-C 56995. A small section of lamellar tissue from all specimens in the collection was examined to ascertain that all were of the same taxon. All collections have been accessioned into the State Herbarium of South Australia (AD).

Collections of *Entoloma pitereka* and *E. byssisedum* from Hobart (HO), Melbourne (MEL) and Perth (PERTH) herbaria were examined as well as the South Australian collections. A small section of lamellar tissue was taken from one specimen from each collection and measurements were made of spores (n = 40) and basidia (n = 20). To avoid further destruction of tissue, the pileipellis was not examined.

### Molecular

DNA was extracted from 5–10 mg of dried specimens by freezing with liquid nitrogen and grinding in a pestle and mortar with 500 µl of pH 8.0 isolation buffer (50 mM Tris-HCl, 170 mM EDTA, 1% N-lauroylsarcosine). The frozen paste was allowed to thaw, transferred to a 1.5 ml Eppendorf tube and incubated at 65°C for 5 min. Following addition of 300 µl 7.5 M ammonium acetate, tubes were mixed by inversion, incubated on ice for 10 min and centrifuged at 13,000 g for 5 min. The supernatant (700 µl) was transferred to a fresh tube, mixed with 500 µl of isopropanol and held on ice for 10 min. Following centrifugation at 13,000 g for 3 min the supernatant was discarded and tubes drained by inversion on paper towel. The pellet was dissolved in 250 µl Tris EDTA buffer (10 mM Tris 1mM EDTA pH 8.0), if necessary by incubation at 50°C for 5 min and brief vortex mixing. PCR amplifications (50 µl) used Phusion polymerase (New England Biolabs) in HF buffer, ITS1, ITS4, LR0R and LR5 primers, as appropriate for the internal transcribed spacer (ITS) and nuclear ribosomal RNA large subunit (28S) respectively (White et al. 1990) and 1 µl of a 1/20 or 1/100 dilution of the DNA extract. Amplification used 5 min at 98°C followed by 40 cycles (98°C 30 s, 55°C 15 s, 72°C 15 s) then 5 min at 72°C prior to storage at 4°C. PCR products were purified using a PCK-1 kit (AdBiotec) and sequenced (AGRF) on both strands with appropriate primers. As amplicons from *E. pitereka* specimens included mould sequences, the required PCR products were excised from gels and recovered using a QIAquick


**Fig. 3.** Fruit bodies of the holotype of ***Entoloma ravinense*** in the laboratory before drying. — Photo: D.E.A. Catcheside, 24 June 2010.

gel extraction kit. DNA sequence assembly from paired reads was checked manually for consistency and for heterozygous sites. Blastn searches for related sequences in GenBank employed NCBI software. Phylogenetic analysis used Geneious 8.1.8 software, MUSCLE for alignment and MrBayes for tree construction using the HKY85 substitution model, 4 heated chains for 1,100,000 iterations including a burn in of 100,000.

## Results

### Taxonomy

***Entoloma ravinense*, P.S.Catches., Vonow & D.E.A.Catches., *sp. nov.***

**Holotype:** South Australia. Kangaroo Island: North facing slope of Ravine des Casoars Wilderness Area, 35° 48' 8.5"S, 136° 36' 43"E, alt. c. 45 m, in *E. cladocalyx* F.Muell. and *E. diversifolia* Bonpl. woodland with *Acacia paradoxa* DC, on wood, underside of bark of *Eucalyptus cladocalyx* F.Muell, 24 June 2010, *P.S. Catcheside, D.E.A. Catcheside & H.P. Vonow PSC 3331* (AD-C 56995).
**Mycobank number:** MB817471.

*Basidiomata* few, scattered to occasionally clumped. Pleurotoid or crepidotoid, with stipe lacking, excentric or lateral (Figs. 1, 2, 3). *Pileus* 5–63 mm diameter, 3–33 mm anteriorly-posteriorly, 1–5 mm high; convex to broadly applanate, circular to fan-shaped when young, becoming semicircular, then reniform; white 4A1 (Kornerup & Wanscher); softly hairy, felty, downy-woolly to tomentose; not hygrophanous, not translucently striate; dry; margin inrolled. *Lamellae* adnexed but distant from top of stipe, radiating from attachment if stipe absent; close, L = 25–60; ventricose; white 4A1 to cream 4A2 when young, becoming pink 5A2 then finally translucent tan 5B4–5 to 5C4; margin concolourous, entire; 2–3 series of lamellulae. *Stipe* absent, substipitate to short-stipitate, lateral or excentric; if present, bent, curving, length 3–5 mm, diameter 2–3 mm; white 4A1 to cream 4A2; finely tomentose. Basal rhizomorphs extensive, forming a subiculum. *Smell and taste* not recorded. *Spore print* pale pink fawn, pinkish tan, 6C4. *Spores* (Fig. 4) 8.0–10.5 × 6.5–8.0 µm, mean 8.26 × 6.95 µm; Q = 1.11–1.44 (–1.56), mean Q = 1.31 (n = 40); 5–7 (8) angled in side view, isodiametric, mostly heterodiametric; inamyloid; hyaline; with one large guttule. *Basidia* (Fig. 5) 38–46 × 8–11 (–12) µm, mean 41.35 × 10.1 µm; clavate; 4-spored; clamp connections not seen. *Cheilocystidia* absent. *Lamella edge* fertile. *Hymenophoral trama* regular, of cylindrical hyphae 3–10 µm diameter. *Pileipellis* (Figs. 6, 7, 8)

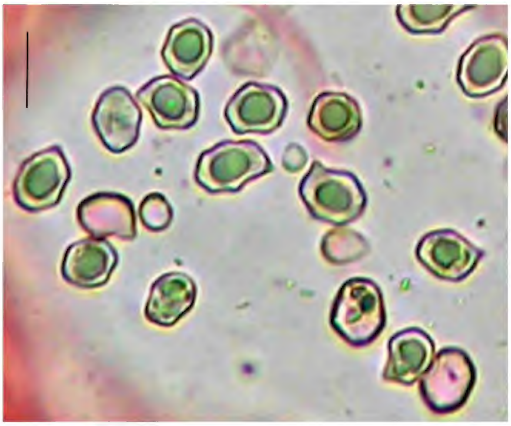

**Fig. 4.** Spores of ***Entoloma ravinense***. Scale bar = 10 µm. — Holotype. Photo: P.S. Catcheside, 16 Dec. 2010.

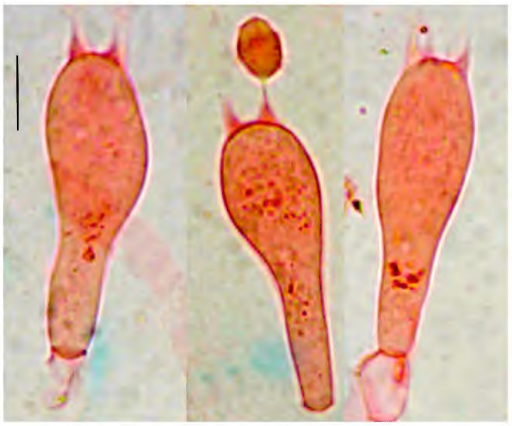

**Fig. 5.** Basidia of ***Entoloma ravinense***. Stained in Congo Red. Scale bar = 10 µm. — Holotype. Photo: P.S. Catcheside. 29 Jan. 2015.

in centre a cutis of interwoven, entangled, cylindrical hyphae, with transition to a trichoderm towards margin; hyphal ends of trichoderm growing perpendicularly to pileipellis, terminal elements 10–25 (–37) × (5–) 7–12 (–15) µm, apices rounded; some hyphae in lower layers with encrustations; clamps absent. *Pileitrama* regular, similar to hymenophoral trama. *Stipitipellis* a cutis of irregular repent hyphae 3–10 µm diameter, with clusters of upright hyphae, terminal ends of hyphae measuring 30–40 (–55) × 4–10 (–14) µm. *Clamp connections* not found in any tissue.

*Etymology*. The specific epithet refers to the type location, the Ravine des Casoars.

*Additional specimens examined.*

South Australia. **Kangaroo Island**: North facing slope of Ravine des Casoars Wilderness Area, 35° 48' 5"S, 136° 36' 50"E, alt. c. 45 m, in *E. cladocalyx* F.Muell. and *E. diversifolia* Bonpl. woodland with *Acacia paradoxa* DC., on wood, underside of bark of *E. cladocalyx*, 24 June 2014, *P.S. Catcheside*, *D.E.A. Catcheside & H.P. Vonow PSC3960* (AD-C 58774); Location near to collections *PSC3331* and *PSC3960*, 35° 48' 8.7"S, 136° 36' 48"E, on similar substrate and in similar plant community, 22 June 2015, *P.S. Catcheside*, *D.E.A. Catcheside & H.P. Vonow PSC4229* (AD-C 59843).

*Other species examined.*

***Entoloma pitereka* Noordel. & G.M. Gates.**

Tasmania. Wielangta, 42° 42'S, 147° 51'E, 19 Feb. 2005, *G. Gates E 2081* (HO 564359; holotype); Duckhole Lane Track, 43° 22'S, 146° 53'E, substrate: wood, habitat: wet sclerophyll, 25 Jan. 2007, *G.M. Gates & D.A. Ratkowsky 1733* (MEL 2363720); Growling Swallett, 42° 41'S, 146° 30'E, substrate: wood, habitat: wet sclerophyll, 1 Jan. 2008, *G.M. Gates & D.A. Ratkowsky 1747* (MEL 2363723).

***Entoloma byssisedum* (Pers.) Donk.**

Western Australia. On old wood, Wanneroo, 31° 45' 0"S, 115° 48' 0"E, 24 Sep. 1978, *J. Daams s.n.* (PERTH 00938424); On very rotten wood just protruding from heap of earth, pine plantation, by gate to old Carinyah Pine Plantation, Karragullen (now MWB), 32° 05' 0"S, 116° 07' 0"E, 29 June 1983, *R.N. Hilton s.n.* (PERTH 00917354).

## Molecular data

A contig of 1588 bp was obtained for *Entoloma ravinense PSC3331* (GenBank accession KX387622) covering 18S partial sequence, ITS1, 5.8S and ITS2 complete sequence and 28S partial sequence from nuclear ribosomal genes. For *E. pitereka* MEL236370, a contig of 618 bp (GenBank accession KX387621) covering ITS1 partial sequence, 5.8S and ITS2 complete sequence and another of 905 bp (GenBank accession KX 387620) covering part of the 28S gene were obtained.

The 596 bp ITS-5.8S rRNA-ITS2 sequence from *E. ravinense* was used to extract 500 related sequences from GenBank on 17 March 2016. The list obtained was reduced to the 213 Entoloma sequences including *E. ravinense* and *E. pitereka*, aligned and trimmed to 787 bp, including gaps, prior to tree building. For the tree constructed from nuclear ribosomal large subunit sequences, GenBank was searched for *Entoloma*, *Nolanea* and *Claudopus* sequences on 21 May 2016. The list obtained was edited to include *E. ravinense*, *E. pitereka* and the 302 other sequences covering ≥ 512 bp of 28S RNA, aligned and trimmed to 678 bp including gaps prior to tree building. Trees constructed from alignments of both sets of sequences show both *E. ravinense* and *E. pitereka* are members of the subgenus *Claudopus* of *Entoloma* (Figs. 9, 10). The full list of sequences included in the analysis is available from the authors.

## Discussion

*Claudopus* is a recognised subgenus of *Entoloma* and forms a clade within *Entoloma* in phylograms based on either 28S or ITS sequences (Figs. 9, 10). Both *E. ravinense* and *E. pitereka* fall within this clade, which Co-David et al. (2009) recognise also contains species formerly assigned to the genus *Nolanea* (Fr.) P.Kumm. In the 28S tree, *E. ravinense* and *E. pitereka* are in different subclades, which also include other Australian species, while in the ITS tree, *E. pitereka* is basal to all

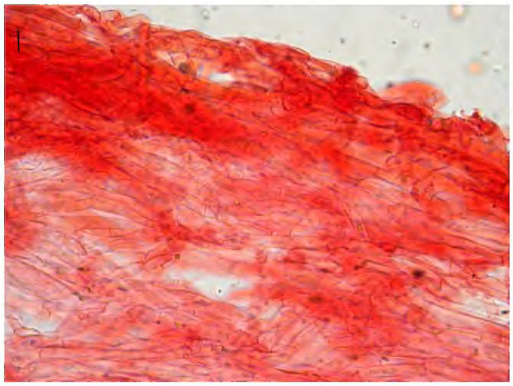

**Fig. 6.** Pileipellis of ***Entoloma ravinense*** in centre of pileus. Stained in Congo Red. Scale bar = 10 µm. — Holotype. Photo: P.S. Catcheside, 27 Apr. 2015.

**Fig. 7.** Pileipellis of ***Entoloma ravinense*** towards margin. Stained in Congo Red. Scale bar = 10 µm. — Holotype. Photo: P.S. Catcheside. 27 Apr. 2015.

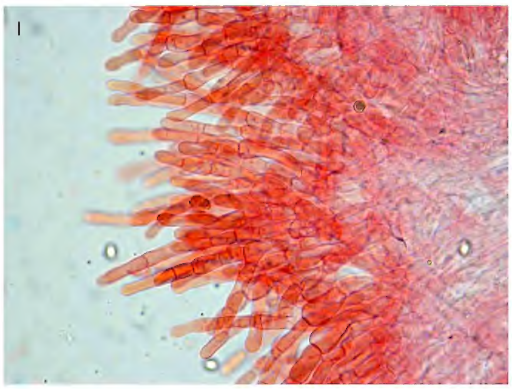

**Fig. 8.** Pileipellis of ***Entoloma ravinense*** at margin. Stained in Congo Red. Scale bar = 10 µm. — Holotype. Photo: P.S. Catcheside. 27 Apr. 2015.

other species of subgenus *Claudopus*, and *E. ravinense* groups with sequences of *E. shandongense* T.Bau & J.R.Wang from China and India and an *E. byssisedum* sequence from Spain.

*Entoloma ravinense* may be distinguished from other white laterally attached (pleurotoid) species of *Entoloma* by its larger and sparse fruit bodies, close lamellae with usually three series of lamellulae, and its larger basidia (Tables 1 & 2). The margin of its pileus is distinctly inrolled, and is densely covered with fine white, woolly hairs. Its stipe is tomentose with a tangle of white mycelial threads proliferating from its base and forming an extensive subiculum or mat. No clamp connections were found, not even at the bases of immature basidia, in spite of an extensive search. Its substrate, fallen bark, also differs from many other white, pleurotoid entolomas.

The only taxa of pleurotoid *Entoloma* that have been described previously from Australia are *Claudopus minutoincanus*, *C. rupestris*, *C. viscosus* and *Entoloma pitereka*, and there is a record by Hilton (1988) of *E. byssisedum*, first described from the Northern Hemisphere. The last species differs from the other four in being pale grey to grey-brown and will be discussed among the non-white members of the subgenus *Claudopus*.

The first three species all grow on the undersides of granitic rocks. They produce abundant fruit bodies, all having white, sticky, small pilei with the largest, *C. viscosus*, having pileus diameter 1.5 to 11 mm (Largent et al. 2011). In contrast, *Entoloma ravinense* grows on the underside of bark, produces few fruit bodies (the most we have found in a location is twelve), the pilei are dry and diameters range from 5 to 63 mm. Microscopically, *Claudopus minutoincanus*, *C. rupestris*, *C. viscosus* and *Entoloma ravinense* are similar in the absence of clamp connections and spore dimensions but *E. ravinense* has larger basidia (38–46 × 8–11 (–12) µm), while those of the largest of the saxicolous taxon, *Claudopus minutoincanus*, are shorter (32.7–38.3 µm) and broader (9.8–13.3 µm).

*Entoloma pitereka* is described as growing in troops on the underside of rotten wood, a somewhat similar substrate to that of *E. ravinense.* The latter species seems to produce no more than three fruit bodies in one clump. Pilei of *E. pitereka* are smaller (1–15 mm diameter), lamellae are subdistant with mostly one series of lamellulae, while *E. ravinense* is larger (5–63 mm) and has close lamellae with mostly three series of lamellulae. Pileus margins of *E. ravinense* are distinctly inrolled at first and remain inrolled, while those of *E. pitereka* are only slightly inrolled and appear to become plane with age. The whole surface of *E. ravinense*, particularly at the margin, is distinctly hairier than that of *E. pitereka.* Microscopically the species have similar spore dimensions, although spores of *E. pitereka* may reach a greater length (*E. pitereka:* 8–12 × 6–8 µm, *E. ravinense* 8–10.5 × 6.5–8 µm) and also have a greater length:width ratio (mean Q = 1.42, n = 20), compared with that for

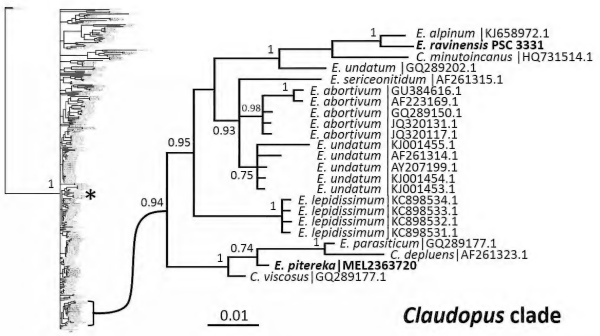


**Fig. 9.** Phylogram from Bayesian analysis of *Entoloma* nuclear rRNA 28S large subunit sequences group *E. ravinense* and *E. pitereka* in the *Claudopus* clade. Figures show the posterior probability of relevant branches. The scale of substitutions per site applies only to the Claudopus clade. The asterisk marks the position of the sequence for *C. rupestris* |HQ731515.1 (Largent et al. 2011), which falls outside this clade. Accession numbers for GenBank follow |. The phylogram is rooted to the GenBank sequence for *E. pamelae* Largent |KJ021702.

*E. ravinense* (mean Q = 1.31, n = 40). The hyphae of the pileipelli of both species are similar, though fewer of the terminal endings of the hyphae of *E. ravinense* were observed to be swollen. However many of the hyphae of its stipe pellis do have swollen, subcapitate terminal endings. In spite of extensive searching in the tissues of *E. ravinense*, no cheilocystidia were found, nor clamp connections, not even at the bases of basidioles. Cheilocystidia were sometimes found in *E. pitereka,* as were clamp connections, although only at the bases of basidia. Basidia of *E. ravinense* are considerably longer (38–46 × 8–11 (–12) µm), in comparison with those of *E. pitereka* (28–34 × 9–11 µm).

Other white pleurotoid Entolomas that have been described are *E. albotomentosum* Noordel. & Hauskn., *E. alliodorum* Esteve-Rav., E. Horak & A. Ortega, *E. exiguum* Esteve-Rav. & M.de la Cruz, *E. jahnii* Wölfel & Winterh. and *E. parasiticum* (Quél.) Kreisel. All are much smaller than *E. ravinense*: the largest, *E. jahnii* recorded as 1–15 mm diameter (Schafer 2008; Nita & Stefaniak 2010; Jančovičova & Adamčik 2012; Noordeloos 2012). Although none have been recorded in Australia, differences between these and *E. ravinense* will be discussed. Noordeloos (2004) commented that in the past few years the number of known *Claudopus* species in Europe has doubled. He suggested that this was due to increased sampling, especially in habitats such as marshy places, not usually associated with rich fungal diversity. It is highly likely that, with the growing awareness and collecting of fungi, the same will apply in Australia.

*Entoloma ravinense* was found fruiting on the underside of shed bark of *Eucalyptus cladocalyx* in eucalypt woodland. *Entoloma albotomentosum, E. alliodorum* and *E. exiguum* have different habitats and substrates. *Entoloma albotomentosum* occurs in marshy places on damp rotten debris of sedges, grasses and herbaceous plants (Halama 2011), *E. alliodorum*, which smells of garlic, grows on organic debris among moss, lichens and very rotten wood (Esteve-Raventós & Ortega 2003). *Entoloma exiguum* has been found amongst plant detritus under herbaceous plants on half-flooded calcareous soils. All three have distant lamellae that are sometimes forked and their basidia are smaller than those of *E. ravinense* (Table 2). *Entoloma exiguum* differs from these in having somewhat larger spores and sac-like basidia. Both *E. alliodorum* and *E. exiguum* have clamp connections, whereas none were found in *E. ravinense*.

*Entoloma jahnii* grows on rotten wood of deciduous trees. It differs from *E. ravinense* in its distant lamellae, larger spores, smaller basidia and presence of clamp connections (Schafer 2008; Nita & Stefaniak 2010; Jančovičova & Adamčik 2012; Noordeloos 2012). *Entoloma parasiticum*, as its name suggests, is parasitic on mushrooms although it is also found on dead wood. Watling & Gregory (1989) report it growing on *Cantharellus cibarius* Fr. and *Polyporus squamosus* (Huds.) Fr., as well as on rotten wood, vegetable debris and 'naked soil'. It has clamp connections and larger spores than *E. ravinense* but similar sized basidia.

Members of the subgenus *Claudopus* that are not white are *Entoloma byssisedum*, *E. pseudoparasiticum* Noordel., *E. depluens* (Batsch:Fr.) Hesl., *E. ollare* E.Ludwig & T.Rödig and *Entoloma alpinum* Xiao L. He, W.H.Peng & B.C.Gan.

All European collections of *Entoloma byssisedum* are reported as having pale grey or brown pilei, though pileus diameters vary: from 3–11 mm (Noordeloos 1988) to 5–35 (–60) mm (Noordeloos 2012). Lamellae are described as crowded, L = 10–25; spores 9.5–12 × 6.5–8 µm, Q = 1.3–1.7 (–1.85), mean Q = 1.45 (Noordeloos 1988); basidia 22–37 × 9–11 µm (Noordeloos 1988); cheilocystidia absent but clamp connections present. Thus *E. ravinense* differs from *E. byssisedum* in pileus colour, number of lamellae, basidia size and absence of clamp connections (Table 2). Horak (2008) described collections from New Zealand of *Claudopus byssisedus* as whitish or greyish, with pileus 3–10 mm and with similar dimensions of spores and basidia to the

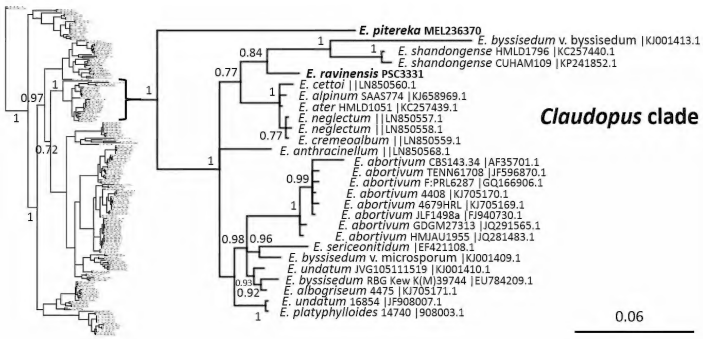


**Fig. 10.** Phylogram from Bayesian analysis of *Entoloma* ITS1, 5.8S rRNA and ITS2 sequences group *E. ravinense* and *E. pitereka* in the *Claudopus* clade. Figures show the posterior probability of relevant branches. The scale of substitutions per site applies only to the *Claudopus* clade. Accession numbers are for GenBank | and EMBL ||. The phylogram is rooted to the GenBank sequence for *E. sphagneti* Naveau |KC710061.1.

European collections, although he reported that clamp connections were absent. *Entoloma byssisedum* has been found and collected in Western Australia (Hilton 1988). The two collections have been examined. In the absence of fuller descriptions of macroscopic characters it is not possible to determine differences with other taxa. However, the dimensions of the basidia conform with Horak's measurements (2008). Molecular data for European collections of *Entoloma byssisedum* show that it and *E. ravinense* are different species. In the absence of molecular data for the New Zealand and Australian collections, it is not possible to determine whether they are the same as the European species.

Other pleurotoid species of *Entoloma* are variously different from *E. ravinense*. *Entoloma pseudoparasiticum* has pale brown pilei and stipes and is parasitic on *Cantharellus cibarius* and *Craterellus lutescens* (Pers.) Fr. (Noordeloos 1987). *Entoloma depluens* is grey, and has cystidia and clamp connections. *Entoloma ollare* is greyish to cream-beige, has distant gills, slightly larger spores but much smaller basidia than *E. ravinense*. *Entoloma ollare* is unusual as having been found only indoors in pots of exotic plants: *Clivia* sp., *Ficus benjamina* L. and *Araucaria heterophylla* (Salisb.) Franco (Mleczko & Ociepa 2007). *Entoloma repens* Petch has been recorded from Tanzania and Sri Lanka (Pegler 1986). It is grey becoming whitish, has widely spaced gills and much smaller spores and basidia. *Entoloma alpinum* from Sichuan Province, China is pale straw yellow, has considerably larger spores, has 2-spored basidia and grows on soil (He et al. 2015).

*Entoloma ravinense* is a rare fungus, found in a specialised environment on very rotten, shed bark of *Eucalyptus cladocalyx*. In spite of intensive surveys in various localities in Flinders Chase National Park it has not been found at any other site. With its remnant vegetation the Ravine des Casoars is an area of significant mycological interest.

## Acknowledgements

We would like to thank Tom May and Genevieve Gates for early comments on this taxon. We are grateful to the State Herbarium of South Australia for their support for fieldwork. We also would like to thank the herbaria in Melbourne (MEL), Hobart (HO) and Perth (PERTH) for providing loan material, Frank Kutsche for his assistance in obtaining relevant scientific collecting permits and Rangers at Flinders Chase National Park for their continual assistance, interest and encouragement.

## References

Co-David, D., Langeveld, D. & Noordeloos, M.E. (2009). Molecular phylogeny and spore evolution of Entolomataceae. *Persoonia* 23: 147–176.

Esteve-Raventós, F. & Ortega, A. (2003). *Entoloma alliodorum*, a new species of subgenus *Claudopus* with a garlic odour. *Mycotaxon* 86: 227–232.

Halama, M. (2011). *Entoloma albotomentosum* (Agaricales, Basidiomycota), a species new to Poland. *Acta Mycologica* 46: 129–136.

### Key to the Australian species of pleurotoid entolomas

**1.** Fruit bodies pale grey, grey-brown . . . . . ***Entoloma byssisedum***
**1:** Fruit bodies white
  **2.** Fruit bodies growing on undersides of granitic rocks; fruit bodies sticky
    **3.** Basidiospores 4–5-angled; pileocystidia not subcapitate to capitate . . . . . ***Claudopus rupestris***
    **3:** Basidiospores 5–6-angled; pileocystidia subcapitate to capitate
      **4.** Basidia smaller, 23.6–33.6 × 8.0–11.5 µm . . . . . ***Claudopus viscosus***
      **4:** Basidia larger, 32.7–38.3 × 9.8–13.2 µm . . . . . ***Claudopus minutoincanus***
  **2:** Fruit bodies growing on woody substrates; fruit bodies not sticky
    **5.** Fruit bodies small, 1–15 mm diameter; lamellae subdistant; pileus margins becoming plane . . . . . ***Entoloma pitereka***
    **5:** Fruit bodies larger, 5–63 mm diameter; lamellae close; pileus margins remaining inrolled . . . . . ***Entoloma ravinense***

**Table 1.** Measurements of macroscopic characters, substrates and sources of data for known pleurotoid species of *Entoloma*. * = measurements made by PSC; n.d. = no data.

| Species | Pileus dimens. (mm) | Colour | Cover | Lamella spacing | Lamellulae | Substrate |
|---|---|---|---|---|---|---|
| *Entoloma ravinense*[1] | 5–63 | white | downy-woolly to tomentose | close, L = 25–60 | 3 | undersurface of fallen bark |
| *E. ravinense* (*PSC3960*)[2] | 6–40 | white | downy-woolly to tomentose | close | 4 | undersurface of fallen bark |
| *E. ravinense* (*PSC4229*)[3] | 7–30 | white | woolly-tomentose | close, L = 11–20 | 3–4 | undersurface of fallen bark |
| *E. pitereka*[4] | 1–15 | white | covered with aeriferous fibrils or tomentose | subdistant | 1? | underside of rotten wood |
| *E. pitereka* (*G&R1733*)[5] | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| *E. pitereka* (*G&R1747*)[6] | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| *E. jahnii*[7] | 1–15 | white to pale pink | finely white hairy-tomentose all over | distant | n.d. | rotten wood |
| *E. jahnii*[8] | 1–15 | white | n.d. | distant | n.d. | rotten wood |
| *E. jahnii*[9] | 2–10 | white, pinkish with age | hairy then tomentose | L = 8–18 | 1–3 | rotten wood |
| *E. parasiticum*[10] | 3–9 | white | entirely tomentose | distant | n.d. | on bark of dead wood |
| *E. parasiticum*[11] | 3–9 | white | entirely tomentose | distant | n.d. | on living mosses, on very rotten bark of coniferous trees, on fungi |
| *E. albotomentosum*[11] | 2–10 | white | silvery white fibrillose when young | very distant, L = 7–10 (–12) | n.d. | on rotten leaf-sheaths and debris of sedges and grasses, marshy places |
| *E. albotomentosum*[8] | 2–10 | white | fibrillose-tomentose | distant | n.d. | on debris of sedges and grasses, marshy places |
| *E. albotomentosum*[12] | 1.5–5.4 | white, turning pinkish | silvery white fibrillose then a centre bundle of agglutinated hairs | very distant, L = 5–14 | n.d. | on debris of herbaceous plants |
| *E. exiguum*[13] | 2–5 | white | uniformly hairy-furfuraceous | distant, L = 7–12 | 0–1 | among plant detritus |
| *E. exiguum*[7] | 2–5 | white | uniformly hairy-furfuraceous | distant, L = 7–12 | 0–1 | among plant detritus in half-flooded, calcareous soils |
| *E. alliodorum*[14] | 3–8 (–10) | white | finely fibrillose to pubescent | moderately distant, L = 15–22 | n.d. | on organic debris, among mosses |
| *E. alliodorum*[7] | 3–8 (–10) | white | finely fibrillose to pubescent | moderately distant, L = 15–22 | n.d. | on organic debris, among mosses |
| *Claudopus rupestris*[15] | 1–4 | white, with very pale yellowish tinges | minutely matted-fibrillose, glistening, sticky | distant, L = 5–8 | 1 | undersurface of rocks |
| *C. viscosus*[15] | 1.5–11 | at first white then off-white to pinkish–white | entirely matted-fibrillose | close then subdistant to distant | 1–3 | rhizoids of moss gametophytes |
| *C. minutoincanus*[15] | 1–3 | whitish, hint of yellowish–white | matted fibrillose, glistening, sticky | close | n.d. | thin layer of soil under rock |
| *E. byssisedum*[10] | 3–11 | pale grey or brown | radially fibrillose to hirsute | crowded, L = 10–25 | 0–5 | on ground, mosses, rotten leaves, wood |
| *E. byssisedum*[11] | 5–35 | pale grey or brown | radially fibrillose to hirsute | rather distant to fairly crowded, L = 10–25 | 0–5 | dead organic material, rotten wood, on ground |

| Species | Pileus dimens. (mm) | Colour | Cover | Lamella spacing | Lamellulae | Substrate |
|---|---|---|---|---|---|---|
| *E. byssisedum*[8] | 3–35 (–60) | pale grey to pale brown | densely covered with silvery fibrils | crowded, L = 10–25 | n.d. | terricolous or on dead plant remains |
| *E. byssisedum*[16] | n.d. | n.d. | n.d. | n.d. | n.d. | rotten wood |
| *E. byssisedum*[17] | n.d. | white | floccose | n.d. | n.d. | old wood |
| *E. byssisedum* (as *C. byssisedus*)[18] | 3–10 | whitish or greyish pale grey to pale brown | radially fibrillose or silky | L = 16–20 | to 3 | on rotting bark and wood |
| *E. byssisedum* var. *microsporum*[7] | to 20 | pale grey-brown | arachnoid-fibrillose tomentum | moderately distant to distant, L = 10–22 | 0–5 | terricolous or on dead plant remains |
| *E. pseudoparasiticum*[19] | 2–10 | pale brown | subtomentose | distant | n.d. | parasitic on *Cantharellus cibarius* and *Craterellus lutescens* |
| *E. pseudoparasiticum*[11] | 2–10 | pale brown | subtomentose | distant | n.d. | parasitic on *Cantharellus cibarius* and *Craterellus lutescens* |
| *E. depluens*[10] | 4–20 | pale grey (brown) | densely white-fibrillose, at centre often tomentose | rather distant[20] | n.d. | on mosses, wood or on ground |
| *E. depluens*[11] | 6–20 | greyish seemingly white | strongly aeriferous surface | rather crowded L = 15–30 | 1–3 | on rotten wood |
| *C. repens*[21] | 4–6 | grey becoming whitish | finely floccose | widely spaced | occasional | underside of rotting logs |
| *E. ollare*[22] | to 9 | greyish to cream and cream–beige | tomentose, sparse short hairs | not crowded | n.d. | in pot with *Araucaria heterophylla* |
| *E. ollare*[7] | 2.5–10 | pale grey then cream | entirely finely tomentose | subdistant | n.d. | in pot with *Araucaria heterophylla* |
| *E. alpinum*[23] | 9-30 | pale straw yellow | Subtomentose felted patches or fibrils when fresh, slightly pallescent on drying | subdistant | 2–3 | On soil in partially disturbed and open grassland |

**Data Sources.** [1] Notes with herbarium collection *PSC3331*, AD-C 56995; [2] Notes with herbarium collection *PSC3960*, AD-C 58774; [3] Notes with herbarium collection *PSC4229*, AD-C 59843; [4] Noordeloos & Gates (2012); [5] Collection *Gates & Ratkowsky 1733*, MEL 2363720; [6] Collection *Gates & Ratkowsky 1747*, MEL 2363723; [7] Noordeloos (2004); [8] Noordeloos (2012); [9] Jančovičova & Adamčik (2012); [10] Noordeloos (1988); [11] Noordeloos (1992); [12] Halama (2011); [13] Esteve-Raventós & de la Cruz (1998); [14] Esteve-Raventós & Ortega (2003); [15] Largent et al. (2011); [16] Hilton (1983); [17] Daams (1978); [18] Horak (2007); [19] Noordeloos (1987); [20] Watling & Gregory (1989); [21] Pegler (1986); [22] Mleczko & Ociepa (2007); [23] He et al. (2015).

He, X.-L., Peng, W.-H. & Gan, B.-C. (2015). Morphological and molecular evidence for a new species in *Entoloma* subgenus *Claudopus* from Sichuan Province, southwest China. *Mycoscience* 56(3): 326–331.

Hilton, R.N. (1988). A census of the larger fungi of Western Australia Part II. *Journal of the Royal Society of Western Australia* 70: 111–118.

Horak, E. (1980). *Entoloma (Agaricales) in Indomalaya and Australasia*. (J.Cramer: Vaduz). [*Beihefte zur Nova Hedwigia* 65].

Horak, E. (2008). *The Fungi of New Zealand*, Vol. 5: *Agaricales of New Zealand 1 – Pluteaceae – Entolomataceae*. (Fungal Diversity Press: Hong Kong).

Jančovičova, S. & Adamčik, S. (2012). *Entoloma jahnii* (Fungi, Agaricales) reported from Slovakia and notes on differences with *E. byssisedum*. *Czech Mycology* 64(2): 209–222.

Kirk, P.M., Cannon, P.F., Minter, D.V. & Stalpers, J.A. (2008). *Ainsworth & Bisby's Dictionary of Fungi*, 10th ed. (CAB International: Wallingford).

Kornerup, A. & Wanscher, J.H. (1978). *The Methuen book of colour.* (Eyre Methuen: London).

Largent, D.L., Abell-Davis, S.E., Cummings, G.A., Ryan, K.L. & Bergemann, S.E. (2011). Saxicolous species of *Claudopus* (Agaricales, Entolomataceae) from Australia. *Mycotaxon* 116: 253–264.

Manimohan, P., Noordeloos, M.E. & Dhanya, A.M. (2006). Studies on the genus *Entoloma* (Basidiomycetes, Agaricales) in Kerala State, India. *Persoonia* 19: 45–93.

Matheny, P.B., Curtis, J.M., Hofstetter, V., Aime, M.C., Moncalvo, J.-M., Ge, Z.-W., Yang, Z.-L., Slot, J.C., Ammirati, J.F., Baroni, T.J., Bougher, N.L., Hughes, K.W., Lodge, D.J., Kerrigan, R.W., Seidl, M.T., Aanen, D.K., De Nitis, M., Daniele, G.M., Desjardin, D.E., Kropp, B.R., Norvell, L.L., Parker, A., Vellinga, E.C., Vilgalys, R. & Hibbett, D.S. (2006). Major clades of Agaricales: a multilocus phylogenetic overview. *Mycologia* 98: 982–995.

May, T.W. & Wood, A.E. (1997). *Catalogue and bibliography of Australian macrofungi 1. Basidiomycota. Fungi of Australia*, Vol. 2A. (Australian Biological Resources Study: Canberra).

**Table 2.** Measurements of microscopic characters and sources of data for known pleurotoid species of *Entoloma*. * = measurements made by PSC; n.d. = no data; av. = average.

| Species | Spore dimensions (mm) | Mean spore dimens. (µm) | Q range | Q mean | Number: spore angle | Basidia (µm) |
|---|---|---|---|---|---|---|
| *Entoloma ravinense* Type (*PSC3331*) [1] | *8.0–10.5 × 6.5–8.0 | *8.26 × 6.95 | *1.11–1.44 (–1.56) | *1.31 | *5–6 (–7) | *38–46 × 8–11 (–12) |
| *Entoloma ravinense* (*PSC3960*) [2] | *8.0–11.0 × 6.5–8.0 (–9.6) | *9.6 × 7.15 | *1.06–1.44 (–1.56) | *1.26 | *5–6 (–7) | *36.8–48.8 × 9.5–12.5 |
| *Entoloma ravinense* (*PSC4229*) [3] | *8.0–11.0 × 6.5–8.0 | *9.12 × 7.275 | *1.1–1.4 (–1.5) | *1.27 | *5–6 | *34–42 × 10–12 |
| *E. pitereka* Holotype [4] | *8.0–12.0 × 6.5–8.0 | *9.92 × 7.0 | *1.11–1.75 | *1.42 | 5–6 | *28–32.8 × 9.6–11.2 |
| *E. pitereka* (*G&R1733*) [5] | *8.0–11.0 × 6.5–8.0 | *9.59 × 7.05 | *1.0–1.6 | *1.36 | 5–6 | *28–32 (–36) × 11–13 (–14) |
| *E. pitereka* (*G&R1747*) [6] | *8.0–11.0 × 6.5–8.0 (–9.0) | *9.52 × 7.43 | *1.09–1.5 | *1.39 | 5–6 | *26–38 × 9–12 |
| *E. jahnii* [7] | (9–) 10–14 (–15) × 7.5–11 (–11.5) | n.d. | 1.0–1.5 (–1.55) | 1.2–1.3 | 5–6 | 30–47 × 10–14 |
| *E. jahnii* [8] | 9.5–13 (–15) × 7.5–10 (–11.5) | n.d. | n.d. | n.d. | 5–6 | n.d. |
| *E. jahnii* [9] | (9–) 10.45–12.9 (–14.8) × (7.5–) 8.1–9.4 (–10.8) | 11.7 × 8.8 | (1.14–) 1.22–1.45 (1.63) | 1.33 | 5–6 (–7) | (25–) 28.5–36 (–41) × 11.5–13 (–15) |
| *E. parasiticum* [10] | 9.5–11.0 × 8.0–9.5 | n.d. | 1.1–1.2 | 1.15 | 4–6 | 24–45 × 10–15 |
| *E. parasiticum* [11] | 9.5–12.5 × 8.0–10.5 (–11.0) | n.d. | 1.1–1.4 | n.d. | 5–6 | n.d. |
| *E. albotomentosum* [11] | 9.0–12.5 × 6.5–8.0 | n.d. | 1.1-1.5 | n.d. | 4–6 | n.d. |
| *E. albotomentosum* [8] | 9–12.5 × 6–8 | n.d. | n.d. | n.d. | 4–6 | n.d. |
| *E. albotomentosum* [12] | (7.23–) 8.86–9.05 (–12.14) × (5.89–) 6.95–7.09 (–8.87) | n.d. | (0.97–) 1.27–1.29 (–1.64) | n.d. | 4–6 | (25.14–) 28.86–30.55 (–36.39) × (9.85–) 11.75–12.64 (–14.50) |
| *E. exiguum* [13] | 9.4–12 × 6.4–8.3 | 10.8 × 7.4 | 1.15–1.75 | 1.45 | 6–8 | 25–32 × 11–12.5 (utriform) |
| *E. exiguum* [7] | (9.5–) 10–12 × 6.5–8.5 | n.d. | 1.15–1.8 | 1.5 | 6–8 | 25–35 × 10–12.5 |
| *E. alliodorum* [14] | 8.8–10.9 × 6.2–7.7 | 9.8 × 7 | n.d. | 1.4 | 6–7 | 30–36 (–42) × 11.5–14 |
| *E. alliodorum* [7] | 8.8–9.8–10.9 × 6.2–7–7.7 | n.d. | 1.44 | | 6–7 | 30–36 (–42) × 11.5–14 |
| *Claudopus rupestris* [15] | 6.5–9.2 × 5.9–8.0 | 8.1 × 6.8 | 1.0–1.36 | 1.18 | 4–5 | 20.8–31.8 × 8.0–11.5 (av. 27.19 × 9.7) |
| *C. viscosus* [15] | 7.7–12.0 × 5.3–7–9 | 9.8 × 6.7 | 1.22–1.88 | 1.47 | 5–6 | 23.6–33.6 × 8.0–11.5 (av. 29.5 × 10.0) |
| *C. minutoincanus* [15] | 7.4–11.4 × 6.3–9.6 | 9.01 × 7.4 | 1.08–1.44 | 1.22 | 6 | 32.7–38.3 × 9.8–13.3 |
| *E. byssisedum* [10] | (9.5–) 10.0–12.0 (–12.5) × 6.5–8.0 | n.d. | 1.3–1.7 (–1.85) | 1.45 | irregular | 22–37 × 9–11.5 |
| *E. byssisedum* [11] | 9.5–12 (–12.5) × 6.5–8 | n.d. | 1.3–1.8 | n.d. | irregular | n.d. |
| *E. byssisedum* [8] | 9.5–12 × 6.5–8 | n.d. | n.d. | n.d. | many | n.d. |
| *E. byssisedum* [16] | *8.0–10.8 × (5.6–) 6.0–7.2 (–8.0) | *9.34 × 6.79 | *1.18–1.53 | *1.38 | n.d. | *25–34 × 8–11 |
| *E. byssisedum* [17] | *8.0–10.4 × 6.0–7.2 | *8.93 × 6.42 | *1.21–1.59 | *1.39 | n.d. | *27–34 × (8–)10–12 |
| *E. byssisedum* (as *C. byssisedus*) [18] | 8–9 × 6–7.5 | n.d. | n.d. | n.d. | 5–6 | 27–36 × 10–12 |
| *E. byssisedum* var. *microsporum* [7] | 7.5–9.5 × 5.5–7.5 | 8.7 × 6.7 | 1.15–1.5 | 1.3 | 5–6 | 32–45 × 10–14 |
| *E. pseudoparasiticum* [19] | 7.5–10( –10.5) × 6.0–7.5 | 8.5–9.0 × 6.5–7.0 | n.d. | n.d. | 5–6 | 30–40 × 8.5–14 |
| *E. pseudoparasiticum* [11] | 7.5–10 (–10.5) × 6.0–7.5 | n.d. | n.d. | n.d. | 5–6 | n.d. |
| *E. depluens* [10] | 8.0–9.0 (–10.0) × 6.0–7.0 (–8.0) | n.d. | 1.2–1.5 | 1.3 | 5–7 | n.d. |

| Species | Spore dimensions (mm) | Mean spore dimens. (µm) | Q range | Q mean | Number: spore angle | Basidia (µm) |
|---|---|---|---|---|---|---|
| *E. depluens*[11] | 8.5–11 × 7–7.5 | n.d. | 1.1–1.5 | 1.3 | 5–7 | n.d. |
| *C. repens*[20] | 5–7.5 × 4–5.5 | 6 × 4.5 | | 1.32 | 5–6 | 21–28 × 6–7 |
| *E. ollare*[21] | 8–12 × 6–9 | 10.1 × 7.4 | 1.3–1.8 | 1.5 | 5–7 (–8) | 16–28 × 6–11 |
| *E. ollare*[7] | 8.5–13 × 6–9 | n.d. | 1.2–1.8 | 1.4–1.5 | 5–7 (–8) | 20–40 × 6–12 |
| *E. alpinum*[22] | 11.5–15 (–16) × (8.5–) 9–11.5 (–13.5) | n.d. | 1.09–1.43 | 1.28 ± 0.03 | 6–10 | 34–40 × 11–12 (2-spored) |

**Data Sources.** [1] Notes with herbarium collection: *PSC3331*, AD-C 56995; [2] Notes with herbarium collection: *PSC3960*, AD-C 58774; [3] Notes with herbarium collection: *PSC4229*, AD-C 59843; [4] Collection *Noordeloos & Gates E 2081*, HO 564359; [5] Collection *Gates & Ratkowsky 1733*, MEL 2363720; [6] Collection *Gates & Ratkowsky 1747*, MEL 2363723; [7] Noordeloos (2004); [8] Noordeloos (2012); [9] Jančovičova & Adamčik (2012); [10] Noordeloos (1988); [11] Noordeloos (1992); [12] Halama (2011); [13] Esteve-Raventós & de la Cruz (1998); [14] Esteve-Raventós & Ortega (2003); [15] Largent et al. (2011); [16] Collection *Hilton s.n.*, PERTH 00917354; [17] Collection *Daams s.n.*, PERTH 00938424; [18] Horak (2007); [19] Noordeloos (1987); [20] Pegler (1986); [21] Mleczko & Ociepa (2007); [22] He et al. (2015).

Mleczko, P. & Ociepa, A.M. (2007). *Entoloma ollare*, a species of subgenus *Claudopus*, new to Poland. *Journal of Polish Botany* 52(2): 159–163.

Nita, J. & Stefaniak, M. (2010). *Entoloma jahnii,* a rare species in Europe. *Acta Mycologica* 45(2): 157–162

Noordeloos, M.E. (1981). Introduction to the taxonomy of the genus *Entoloma* sensu lato (Agaricales). *Persoonia* 11: 121–151.

Noordeloos, M.E. (1987). *Entoloma (Agaricales) in Europe*. (J. Cramer: Berlin). [*Beihefte zur Nova Hedwigia* 91].

Noordeloos, M.E. (1988). *Entoloma*. In: Bas, C., Kuyper T.W., Noordeloos, M.E. & Vellinga, E.C. (eds.), *Flora agaricina neerlandica* 1: 85–177. (Rotterdam: Brookfield).

Noordeloos, M.E. (1992). *Entoloma* s.l. (Libreria editrice Giovanna Biella: Saronno). [*Fungi Europaei* 5].

Noordeloos, M.E. (2004). *Entoloma* s.l. *(Supplemento).* (Edizioni Candusso: Alassio). [*Fungi Europaei* 5A].

Noordeloos, M.E. (2012). *Entoloma* (Fr.) P.Kumm. In: Knudsen, H., Vesterholt, J. (eds). *Funga Nordica. Agaricoid, boletoid and cyphelloid genera*. (Nordsvamp: Copenhagen).

Noordeloos, M.E. & Gates, G.M. (2012). *The Entolomataceae of Tasmania*. (Springer: Dordrecht). [*Fungal Diversity Research Series* 22].

Pegler, D.N. (1986). *Agaric Flora of Sri Lanka*. (HMSA: London). [*Kew Bulletin Additional Series* 12].

Schafer, D. (2008). Persistence pays off — *Entoloma jahnii*, a new British record. *Field Mycology* 9: 49–50.

Watling, R. & Gregory, N.M. (1989). *British fungus flora, Agarics and Boleti*, Part 6: *Crepidotaceae, Pleurotaceae and other pleurotoid agarics*. (Royal Botanic Garden: Edinburgh).

White, T.J., Bruns, T., Lee, S.J.W.T. & Taylor, J.W. (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis, M.A., Gelfand, D.H., Sninsky, J.J. & White, T.J. (eds.), *PCR protocols: a guide to methods and applications* 18(1): 315–322. (Academic Press: San Diego).

*Journal of the Adelaide Botanic Gardens* 29 (2016) 53–69


# A synopsis and key for the lichen genus *Caloplaca* (Teloschistaceae) on Kangaroo Island, with the description of two new species

*Gintaras Kantvilas*

Tasmanian Herbarium, Tasmanian Museum and Art Gallery, Private Bag 4, Hobart, Tasmania 7001
*E-mail*: Gintaras.Kantvilas@tmag.tas.gov.au

## Abstract

An identification key and short diagnoses are presented for the thirty-two species of the lichen genus *Caloplaca* Th.Fr. recorded from Kangaroo Island, South Australia. In addition, two new saxicolous species, *C. aggregata* Kantvilas & S.Y.Kondr. occurring on limestone and *C. sergeyana* Kantvilas from siliceous rocks, are described.

**Key Words:** biodiversity, lichens, new taxa, identification, South Australia.

## Introduction

The lichen genus *Caloplaca* Th.Fr. is a highly prominent component of the southern Australian, maritime lichen flora, especially in lower rainfall areas. It is responsible for the orange, red and yellow banding of coastal rocks, but it is also found away from the littoral zone on bark, wood, calcareous and siliceous rocks, and consolidated soil in open forest, woodland and heathland, as well as in areas disturbed or modified by man. The thallus of *Caloplaca* can be highly variable, ranging from subfruticose to placodioid, squamulose, crustose or areolate; in some species the thallus is endosubstratic and hardly evident. Nevertheless, the genus is easily recognised, being characterised by apothecial ascomata, *Teloschistes*-type asci and hyaline, usually polaribilocular ascospores, where the two spore locules are separated by a thick septum pierced by a central channel (Kantvilas & Kondratyuk 2013). In addition, most species contain orange or yellowish, K+ purple anthraquinone pigments in their thallus and/or apothecia.

For decades, the identification of species of *Caloplaca* in Australia was a near-impossible task. The diversity of taxa was clearly very high, but published taxonomic accounts, almost invariably based on Northern Hemisphere floras, clearly did not include many, if any, of the species present. It has been only in the last two decades that the diversity of Australian *Caloplaca* species has been elucidated, almost entirely through the efforts of the Ukrainian lichenologist, Sergey Kondratyuk. Together with several collaborators (chiefly Ingvar Kärnefelt, Sweden), Kondratyuk described more than 75 species based on Australian types (Kantvilas & Kondratyuk 2013; Kärnefelt & Kondratyuk 2004; Kondratyuk et al. 2007a, 2007b, 2009a, 2009b, 2010, 2011, 2013a; Lumbsch et al. 2011), with this work culminating in a key to the more than 120 species recorded for Australia (Kondratyuk et al. 2012). Meanwhile, phylogenetic studies using DNA sequence data indicated that the genus is heterogeneous (Gaya et al. 2012; Søchting & Lutzoni 2003), leading to the erection of dozens of smaller, more natural genera (Arup et al. 2013; Kondratyuk et al. 2013b, 2014a, 2014b, 2015), many with representatives in Australia. This new classification has not been without controversy, as well as proving unwieldy to most taxonomists working with traditional morphological and anatomical characters. Consequently, it has not been generally taken up (e.g. see Gaya et al. 2015; McCarthy 2016). Furthermore, because of its easy recognition, *Caloplaca* in the broad sense is likely to continue to be applied in Australia for the foreseeable future.

Despite the large number of species based on Australian types, the numerous papers on the topic, and large numbers of specimens held in Australian herbaria, identification of Australian collections has remained problematic. Almost any detailed investigation that requires identification to species rank encounters inconsistencies between published descriptions, designated type specimens, herbarium reference material and the key of Kondratyuk et al. (2012). This has certainly been this author's experience in the course of compiling a catalogue of Kangaroo Island lichens, where *Caloplaca* has been one of the largest genera encountered. Thirty-two species have been recorded for the island, but their identification has been a major challenge. In this paper, I summarise the results of my attempts to resolve the Kangaroo Island *Caloplaca* flora through extensive fieldwork and collecting, study of my own collections, type specimens, herbarium reference material and the literature. The paper offers a synopsis of the taxa based on their salient features, as well as an identification key. Two further new species, one of which honours the work of Sergey Kondratyuk, are also described.

## Material and methods

*Specimens.* The study is based principally on the collections of *Caloplaca* from Kangaroo Island, compiled by the author between 2008 and 2015 and housed in the Tasmanian Herbarium (HO), supplemented by specimens from other collectors. Other critical resources employed include an extensive comparison with type material (held in various herbaria as cited), reference herbarium specimens, published accounts of species, and correspondence and duplicate specimen exchange with Dr S. Kondratyuk, the architect of current Australian *Caloplaca* taxonomy, in Kiev.

The importance of study of type specimens cannot be overestimated in this instance. The recent history of *Caloplaca* studies in Australia has been a chequered one. There are large holdings of specimens in Australian herbaria, especially CANB, HO and MEL, which were studied and annotated by Kondratyuk. However, these annotations often represent snapshots in time as species concepts for Australian taxa evolved. Hence there may be inconsistencies in the names that have been employed, and the taxa they have been applied to. Likewise, there are inconsistencies between some published descriptions and the specimens cited in their compilation.

*Methodology.* Observations of specimens were conducted in the field and, subsequently, in the laboratory using low-power and high-power microscopy. Thin sections of the apothecia, cut by hand for the observation of apothecial structure and anatomy, were examined in a range of mounting media, including water, 10% KOH (K) and lactophenol cotton blue (LCB). It is generally acknowledged that *Caloplaca* ascospores may swell, depending on the mounting medium. Because spore and septum dimensions are critical in the delineation of taxa, all measurements were undertaken *exclusively* in sections hydrated in water and then mounted in LCB. Likewise, observations of paraphyses and oil vacuoles were undertaken in LCB. That all measurements are standardised in this way is critical, because unless the mounting medium is specifically stated, ascospores dimensions cannot be compared with confidence.

*Characters in Caloplaca.* Most recently described Australian taxa are accompanied by extensive morphological and anatomical descriptions (see the numerous papers by Kondratyuk as listed in the bibliography). I have distilled my own observations down to a limited number of salient features that, in my opinion, adequately delimit the taxa:

- morphology and colour of the thallus, including presence of vegetative diaspores
- insertion of the apothecia (viz. immersed, adnate, basally constricted etc.) and their colour
- the apothecial margin (biatorine, zeorine or lecanorine), observed in thin section; zeorine is applied where a two-layered margin is clearly present, the inner or "proper" one lacking algal cells, and the outer one with algal cells
- presence of oil droplets in the hymenium and/or in the tissue immediately below (termed the subhymenium)
- structure of the paraphyses, particularly the presence of oil vacuoles in the filaments proper or in the apical cells
- dimensions of ascospores and the ascospore septum, based on 25–50 observations.

**Fig. 1.** ***Caloplaca aggregata*** (holotype) habit; note the tightly clustered apothecia. Scale = 1 mm.

Thallus chemistry is important where xanthones or depsides may be present in addition to other, more typical "*Caloplaca* substances" such as parietin. These additional metabolites are noted, but the other compounds are not, as their identification requires specialist skills. They are rarely critical in delineating taxa studied, although they tend to support morphological and anatomical characters.

*Presentation of data.* Although in some cases, large numbers of specimens of various provenance have been examined, I have limited the descriptive data presented solely to Kangaroo Island specimens. Significant deviations from the type collection are noted where appropriate. Whereas all available collections were studied anatomically and morphologically, only a selection of these (up to a maximum of three per taxon) is cited; a complete list of Kangaroo Island specimens of *Caloplaca* (and other genera) will be given in a later publication. Descriptions are condensed along the lines given above and measurements are presented as a simple range. Only in the case of the new taxa are more comprehensive descriptions provided, and ascospore dimensions, based on 50 observations, are presented in the format: 5$^{th}$ percentile–*average*–95$^{th}$ percentile, with outlying values in brackets. The published protologues of species sometimes indicate that type specimens are present in certain herbaria where they could not to be located. Consequently, I have limited citation of types to specimens that I have actually seen myself.

**Key to the species of *Caloplaca* recorded from Kangaroo Island**

**1.** Growing on wood or bark
- **2.** Orange or yellow, K+ purple anthraquinone pigments entirely lacking; apothecia black ..... ***C. kalbiorum***
- **2:** Orange or yellow, K+ purple pigments present in the apothecia and sometimes also in the thallus
  - **3.** Thallus sorediate, isidiate or composed of isidia-like granules
    - **4.** Thallus pale greyish, continuous or endophloeodal; soredia orange-yellow, occurring in roundish, excavate, crater-like soralia to 0.5 mm wide ..... ***C. wilsonii***
    - **4:** Thallus with at least some yellowish or orange tones, subsquamulose, granular or entirely sorediate, if endophloeodal or ± absent then soredia dispersed or clumped in irregular, superficial soralia
      - **5.** Thallus subsquamulose, orange to brownish orange ..... ***C. erythrosticta***
      - **5:** Thallus granular, isidioid or ± entirely sorediate, some tone of yellowish
        - **6.** Apothecia biatorine, sometimes with yellow-orange thalline tissue concolorous with the disc developing at the base ..... ***C. tibellii***
        - **6:** Apothecia at first biatorine, soon lecanorine to zeorine, with a whitish or pale grey-green thalline margin
          - **7.** Thallus composed of minute, scattered, isidioid granules; apothecia to 1 mm wide, biatorine to zeorine; disc yellow to orange-yellow ..... ***C. gilfillaniorum***
          - **7:** Thallus composed of minute granules that become sorediate; apothecia to 1 (–2) mm wide, usually soon lecanorine; disc orange to orange-pink ..... ***C. kaernefeltii***
  - **3:** Thallus rimose-areolate, squamulose, lobate or absent, never sorediate, isidiate or granular
    - **8.** Apothecia mostly becoming lecanorine to zeorine, developing a greyish, somewhat incomplete thalline margin that contrasts with the yellow or orange disc
      - **9.** Apothecia to 1.2 mm wide, superficial; disc brownish orange; hymenium densely inspersed with oil droplets ..... ***C. bastowii***
      - **9:** Apothecia to 0.5 mm wide, often rather immersed when young; disc yellow to orange; hymenium not inspersed with oil droplets ..... ***C. maccarthyi***
    - **8:** Apothecia persistently biatorine, with the proper margin ± concolorous with the disc
      - **10.** Thallus commonly pale glaucous grey to beige-brown, containing lichexanthone; apothecia strictly biatorine and entirely lacking algal cells (observe in section), to 1.5 mm wide, with margin usually flexuose and lobed ..... ***C. dahlii***
      - **10:** Thallus endophloeodal and inconspicuous, lacking lichexanthone; apothecia biatorine but usually with algal cells at the base (evident in section), to 0.5 mm wide, with margin neither flexuose nor lobed
        - **11.** Apothecia bright yellow; ascospores 7.5–11 × 4–6 µm ..... ***C. subluteoalba***
        - **11:** Apothecia orange; ascospores 10–13 × 5–7 µm ..... ***C. cliffwetmorei***

**1:** Growing on rock or soil
- **12.** Thallus sorediate
  - **13.** Thallus dull rusty brownish orange; soredia concolorous with the thallus or greenish yellow; growing on siliceous substrata ..... ***C. ferdinandmuelleri***
  - **13:** Thallus greyish to yellow or orange; soredia bright yellow or orange-yellow; growing on calcareous or nutrient-enriched substrata
    - **14.** Thallus pale greyish yellow, composed of small squamules c. 1 mm thick with plicate, effigurate margins; soredia arising from the underside of the margins, eventually spreading across the upper surface ..... ***C. kantvilasii***
    - **14:** Thallus bright yellow to orange-yellow, composed of thin, adnate areoles; soredia arising from the eroding upper surface and margins of the areoles ..... ***C. cranfieldii***
- **12:** Thallus not sorediate
  - **15.** Thallus well-developed and comprising the dominant and conspicuous part of the lichen, entirely or in part a shade of yellow, orange or reddish, K+ purple (anthraquinones present), with or without ± concolorous apothecia
    - **16.** Thallus subfoliose to placodoid, with radiating, plicate marginal lobes 0.3–0.8 mm wide ..... ***C. tomareeana***
    - **16:** Thallus crustose, rimose-areolate or squamulose, lacking conspicuous marginal lobes
      - **17.** Thallus bright yellow, at first rimose-areolate, becoming papillate to ± subfruticose ..... ***C. sublobulata***
      - **17:** Thallus a shade of orange, red or pink, rimose-areolate, ± smooth to bullate but never papillate
        - **18.** Thallus comprised of dispersed or imbricate squamules, sometimes with effigurate margins, rusty brownish orange; ascospores 12–18 × 6–9 µm ..... ***C. rexfilsonii***
        - **18:** Thallus crustose, a shade of yellow, yellow-orange or orange-red, sometimes mottled; ascospores 7–14 × 4–7 µm
          - **19.** Apothecia initially immersed and rather aspicilioid, remaining so or becoming adnate at maturity
            - **20.** Thallus vivid orange-red, containing gyrophoric acid; apothecia adnate at maturity with the margin and disc concolorous with the thallus ..... ***C. brownlieae***
            - **20:** Thallus greyish pink to pale orange-pink, lacking gyrophoric acid; apothecia remaining immersed and aspicilioid, with a pink-red disc and thin, pale, ± orange margin ..... ***C montisfracti***
          - **19:** Apothecia basally constricted from the earliest stages

**21.** Thallus mottled yellowish or orange with shades of pale grey or greenish grey, sometimes in concentric zones ..... ***C. jackelixii***
**21:** Thallus ± uniformly yellowish, orange or reddish, never mottled
**22.** Thallus centrally bullate and wrinkled, minutely effigurate-lobed at the margin, lacking a prothallus ..... ***C. eos***
**22:** Thallus ± smoothly rimose-areolate throughout, lacking an effigurate margin; prothallus effuse, wispy, concolorous with the thallus or a little paler, usually evident at the thallus margin or between the areoles ..... ***C. gallowayi***
**15:** Thallus pale yellowish grey, greyish brown to greenish brown or inconspicuous, K– (lacking anthraquinones), sometimes comprised of scattered, orange or yellowish, K+ purple areoles, but these are inconspicuous relative to the apothecia; yellow, orange or reddish tones conveyed solely or predominantly by the apothecia
**23.** Thallus dull greenish, brownish or brownish grey, usually forming a conspicuous background that contrasts with the brightly coloured apothecia
**24.** Apothecia dull rusty orange-brown, sometimes becoming zeorine to lecanorine, with a pale grey thalline margin; hymenium and hypothecium densely inspersed with oil droplets; containing lichexanthone ..... ***C. kilcundaensis***
**24:** Apothecia orange-yellow, persistently biatorine; hymenium and hypothecium not inspersed; lichexanthone absent ..... ***C. sergeyana***
**23:** Thallus absent, inconspicuous, or a shade of whitish, pale grey or pale yellow-orange that blends into the substratum; overall appearance dominated by apothecia
**25.** At least some apothecia developing a zeorine, usually incomplete and/or mainly basal thalline margin that is paler than and contrasts with the yellow or orange disc
**26.** Apothecia 0.1–0.3 mm wide; disc yellow-orange; growing on nutrient enriched substrata ..... ***C. holocarpa***
**26:** Apothecia 0.4–1 mm wide; disc bright orange to orange-pink, sometimes with a whitish pruina; growing exclusively on limestone ..... ***C. johnwhinrayi***
**25:** All apothecia persistently biatorine, or at least with any thalline margin concolorous with the disc
**27.** Growing on siliceous rocks
**28.** Apothecia rusty brownish orange; thallus reduced and consisting of scattered, rusty brownish areoles ..... ***C. lateritia***
**28:** Apothecia yellow; thallus not apparent ..... ***C. piscatorica***
**27:** Confined exclusively to limestone
**29.** Apothecia tightly clustered and producing ± pulvinate clumps that obscure a thallus of scattered areoles ..... ***C. aggregata***
**29:** Apothecia scattered; thallus not apparent
**30.** Ascospores 14–18 × 6–9 µm; hymenium inspersed with oil droplets; paraphyses with occasional oil vacuoles; apothecia brownish orange ..... ***C. jerramungupensis***
**30:** Ascospores 9–13 × 3.5–7 µm; hymenium not inspersed; oil vacuoles lacking; apothecia yellow or orange
**31.** Apothecia yellow; ascospores 8–11 × 3.5–5 µm ..... ***C. yorkensis***
**31:** Apothecia orange-yellow to orange or reddish orange; ascospores 9–13 × 5–7 µm ..... ***C. mereschkowskiana***

## New species

***Caloplaca aggregata* Kantvilas & S.Y.Kondr., *sp.nov.***

*Habitu plus minusve pulvinato, thallo inconspicuo, areolato, apotheciis aggregatis tecto, hymenio subhymenioque guttulis inspersibus, et ascosporis parvis, 9–14 µm longis, 4.5–6 µm latis designata.*

**Typus:** South Australia, Kangaroo Island: Windmill Bay, 35°51'S 138°07'E, 20 m alt., on outcropping limestone in coastal pasture, 17 Sep. 2012, *G. Kantvilas 476/12* (holo.: HO 5567239; iso.: KW-L).

**Mycobank no.:** MB817744.

*Thallus* crustose, areolate, forming irregular, undelimited, rather pulvinate patches to 30 mm wide, dominated almost entirely by clustered apothecia; individual areoles yellow-orange, 0.2–0.5 mm wide, to 200 µm thick, scattered or contiguous, soon obscured by apothecia, with a cortex 20–30 µm thick, consisting of short-celled, anticlinal hyphae 5–10 µm thick; photobiont cells ± globose, 6–24 µm wide. *Apothecia* 0.3–1 mm wide, very numerous, becoming tightly clustered, roundish to distorted-rhomboid due to mutual pressure, sessile to basally constricted, at first zeorine but, with maturity, the thalline margin becoming increasingly incomplete, crenulate and basal, at length ± biatorine; disc somewhat deeper orange than the thallus, at first plane, becoming convex in the oldest apothecia, matt, epruinose; proper margin concolorous with the disc, rather glossy, entire or a little flexuose, persistent but increasingly less conspicuous in older apothecia, in section 40–60 µm thick at the sides and at least in part inspersed with golden-yellow crystals that turn crimson and partially dissolve in KOH, composed of radiating, ± parallel, anastomosing hyphae 5–7 µm thick with lumina 2–4 µm wide at the sides, ± paraplectenchymatous towards the base. *Subhymenium* hyaline, ± wedge-shaped and c. 90–150 µm thick centrally but thinner at the sides, very heavily inspersed with oil droplets that frequently coalesce to form irregular oil bodies 10–20 µm wide. *Hymenium* 60–70 µm thick, hyaline, inspersed with oil droplets, overlain by a dense

**Fig. 2. *Caloplaca sergeyana*** (holotype) habit. Scale = 1 mm.

band of golden-yellow crystals as in the apothecial margin, rather poorly differentiated from the subhymenium; paraphyses slender, 1.5–2 µm thick, lacking oil vacuoles, sparsely branched, expanding to 3.5–6 µm at the apices; asci 8-spored, 40–55 × 12–16 µm. *Ascospores* polaribilocular, ellipsoid, (9–) 10–*11.3*–13.5 (–14) × (4.5–) 5–*5.4*–6 µm; septum (1.5–) 2–*2.5*–3 µm. *Pycnidia* not found. *Chemistry*: not analysed. **Fig. 1.**

*Etymology*. The species epithet alludes to the densely clustered apothecia.

*Remarks*. The pulvinate habit of this species, with its densely clustered apothecia that essentially obscure the thallus, in combination with a very densely inspersed hymenium and subhymenium and relatively small ascospores are extremely distinctive, and I am unaware of any other similar species. Amongst the complement of Australian species of *Caloplaca*, *C. aggregata* is best compared to the other major limestone-inhabiting species with which it may occur. Both *C. mereschkowskiana* and *C. yorkensis* lack a conspicuous thallus, do not have an inspersed hymenium or subhymenium, and the latter differs further by having lemon-yellow apothecia. *Caloplaca jerramungupensis* has an inspersed hymenium, but has paraphyses with oil vacuoles and markedly larger ascospores. None of the species mentioned has clustered apothecia. The distinctiveness of *C. aggregata* is also supported by preliminary molecular data (S. Kondratyuk, pers. comm.).

*Distribution and ecology.* The new species is known only from the type collection, from outcrops of limestone in a coastal sheep paddock on the Dudley Peninsula, Kangaroo Island. Since it was first collected in 2012, this and similar sites have been searched for additional material without success. The new species forms isolated "islands" within an expanse of *Lecanora sphaerospora* Müll.Arg., one of the dominant calcicolous lichens known from the island. Other lichens present in this species-rich habitat include *Buellia albula* (Nyl.) Müll. Arg., *B. xantholeuca* Bungartz & U.Grube, *Caloplaca johnwhinrayi*, *C. kantvilasii*, *C. mereschkowskiana*, *C. yorkensis* and *Lecania turicensis* (Hepp) Müll.Arg.

There is a further collection (*J.B. Cleland*, AD-C 59907) from the Rocky River area which shares with *C. aggregata* the limestone habitat and the clustered apothecia. However, as no well-developed ascospores could be located and the subhymenium is not markedly inspersed (possibly an artefact of the age of the specimen), its identity cannot be confirmed.

***Caloplaca sergeyana* Kantvilas, *sp.nov.***

Caloplacae dahlii *Elix, S.Y.Kondr. & Kärnefelt similis et item apotheciis vere biatorinis, aurantiaco-flavis, ascosporis 11–17 µm longis, 5–8.5 µm latis, septo 3–7 µm crasso sed thallo saxicola, furfuraceo, lichexanthonicum destituto differt.*

**Typus:** South Australia, Kangaroo Island: Creek Bay Farm, 35°50'S 138°06'E, 85 m alt., on rocks in malle woodland, 12 Sep. 2013, *G. Kantvilas 378/13* (holo.: HO 571447; iso.: KW-L).

**Mycobank no.:** MB817745.

*Thallus* crustose, very uneven and scurfy and following the texture of the coarse substratum, forming irregular, undelimited patches to 30–40 mm wide, dull greenish grey to brownish grey, in places to 250 µm thick but generally much thinner; photobiont cells ± globose, 5–15 µm wide. *Apothecia* 0.5–0.8 (–1) mm wide, scattered, orange to orange-yellow, strictly biatorine, sessile, basally constricted; disc at first concave, then plane to undulate, matt, epruinose; proper margin initially ± inrolled, rather glossy, with age sometimes a little flexuose, persistent and elevated above the level of the disc, in section cupular, 60–80 µm thick at the sides, (60–) 70–120 µm thick centrally, hyaline within but with an outer layer c. 10 µm thick of dense, golden-yellow crystals that turn crimson and dissolve in KOH, composed of radiating, ± parallel, anastomosing hyphae 3–5 µm thick with lumina 2–3 µm wide, never containing any photobiont cells. *Subhymenium* hyaline except for a yellowish band in the lowermost part, 30–40 µm thick, not inspersed. *Hymenium* 70–80 µm thick, hyaline, not inspersed, overlain by a dense band of golden-yellow crystals as in the apothecial margin; paraphyses slender, 1.5–2 µm thick, lacking oil vacuoles, becoming more richly branched in the uppermost part, with apices mostly slightly expanded to 3–4 (–5) µm; asci mostly 8-spored, 40–55 × 15–20 µm. *Ascospores* polaribilocular, broadly ellipsoid, (11–) 11.5–*14.1*–16 (–17) × (5–) 6–*7.1*–8 (–8.5) µm; septum 3–*5.3*–7 (–9) µm. *Pycnidia* not found. *Chemistry*: parietin only. **Fig. 2.**

*Etymology.* This species is named after my friend and colleague, Dr Sergey Kondratyuk, of Kiev, Ukraine, in acknowledgement of his enormous contributions to the taxonomy of the genus *Caloplaca* in Australia.

*Remarks*. At first sight, this species recalls the common epiphytic species, *C. dahlii*, and both taxa share orange to orange-yellow apothecia that are strictly biatorine, with

**Fig. 3.** ***Caloplaca gallowayi*** habitat. This species is usually the dominant contributor to the orange-red zonation of the littoral zone.

absolutely no photobiont cells included within or enveloping the apothecial margin. Ascospore and septum dimensions, and the morphology and anatomy of the paraphyses and apothecial margin are essentially the same in these two species. However, in addition to their different substrate ecologies, the two species differ in that *C. sergeyana* has a scurfy, poorly developed thallus that lacks lichexanthone, whereas *C. dahlii* has a conspicuous, well developed thallus containing copious concentrations of this substance. Also somewhat similar is *C. kilcundaensis,* which has a pale brownish grey thallus containing lichexanthone, but differs by having apothecia with a rusty orange-brown disc and a pale grey thalline margin, and a densely inspersed hymenium and subhymenium.

*Distribution and ecology.* The new species is known only from the type collection, from boulders of a coarse sandstone in mallee woodland on the Dudley Peninsula, Kangaroo Island. This habitat was relatively depauperate with respect to lichens owing to the shaded conditions and the effect of litter fall that had smothered many of the rocks. Other lichens recorded on these rocks included: *Candelariella vitellina* (Hoffm.) Müll. Arg., *Megalaria subtasmanica* Kantvilas, *Caloplaca holocarpa* (Hoffm.) A.E.Wade, *C. ferdinandmuelleri* S.Y.Kondr. & Kärnefelt, *Xanthoparmelia mougeotina* (Nyl.) D.J.Galloway, *X. subprolixa* (Nyl. ex Kremp.) O.Blanco et al., *X. xanthomelaena* (Müll.Arg.) Hale, *Lecidella sublapicida* (C.Knight) Hertel and *Lecanora mobergiana* Lumbsch & Elix

## Synopsis of the other species

***Caloplaca bastowii*** **S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 99: 260 (2009); *Franwilsia bastowii* (S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Kärnefelt, A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 56: 111 (2014). — **Type:** Australia, Victoria: Gippsland Plain, Mornington, 38°13'S 145°01'E, 9 Feb. 1901, *R.A. Bastow* (holo.: MEL!).

Thallus crustose, bullate and wrinkled, pale grey to brownish grey; apothecia lecanorine, to 1.2 mm wide, basally constricted; margin whitish grey; disc brownish orange; hymenium and subhymenium densely inspersed with oil droplets; paraphyses lacking oil vacuoles, with apices not markedly enlarged; ascospores 9–13 × 4–6 µm; septum 2–4 µm.

On bark in coastal heathland.

*Specimen examined.* Point Ellen, 36°00'S 137°11'E, 3 m alt., 2013, *G. Kantvilas 221/13* (AD, HO, KW).

***Caloplaca brownlieae*** **S.Y. Kondr., Elix & Kärnefelt**

in Lumbsch et al., Phytotaxa 18: 28 (2011); *Neobrownliella brownlieae* (S.Y.Kondr., Elix & Kärnefelt) S.Y.Kondr., Elix, Kärnefelt & Thell, Acta Bot. Hungarica 57: 340 (2014). — **Type:** Australia, New South Wales: above Lake Eucumbene, on granite boulder, April 1969, *Brownlie* (holo.: MEL!).

Thallus crustose, rimose-areolate, very tightly adnate (like a splash of paint), vivid orange-red, containing gyrophoric acid; apothecia biatorine, to 0.6 mm wide, at first immersed, then adnate; margin and disc con-

colorous with the thallus; hymenium not inspersed; subhymenium with very occasional oil droplets; paraphyses lacking oil vacuoles but with apical cells enlarged to 4 µm; ascospores 10–12.5 × 4–7 µm; septum 2.5–5 µm.

On siliceous rocks in dry sclerophyll woodland. This species was for a short time synonymised with *Caloplaca aequata* (Hue) Zahlbr. and included in the genus *Brownliella* by Kondratyuk et al. (2013b).

*Selected specimens examined.* Ironstone Hills near Harry Bates' cottage, 35°43'S 137°58'E, 90 m alt., 2011, *G. Kantvilas 313/11* (AD, HO); Creek Bay Farm, 35°50'S 138°06'E, 85 m alt., 2013, *G. Kantvilas 372/13* (AD, HO); Lathami Conservation Park, 35°38'S 137°14'E, 160 m alt., 2015, *G. Kantvilas 290/15 & B. de Villiers* (HO).

***Caloplaca cliffwetmorei* S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 100: 236 (2009). — **Type:** Australia, Tasmania: Flinders Island, Yellow Beach, c. 80 m from its western end, on living and dead branches of a huge *Acacia longifolia* var. *sophorae* tree at the head of the beach, 8 July 1978, *J.S. Whinray 1229* (holo.: MEL!; iso.: HO!).

Thallus crustose, inconspicuous, endophloeodal; apothecia biatorine, sometimes with an incipient thalline margin at the base, to 0.5 mm wide, sessile, typically very numerous; proper margin and disc orange; hymenium and subhymenium not inspersed; paraphyses with occasional oil vacuoles 5–7 µm wide occurring in chains, but with apices not enlarged; ascospores 10–13 × 5–7 µm; septum 3–5 µm.

On bark in coastal heathland.

*Specimen examined.* Ravine des Casoars, at the coast, 35°48'S 136°35'E, 5 m alt., 2012, *G. Kantvilas 446/12* (AD, HO, KW).

***Caloplaca cranfieldii* S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 95: 352 (2007); *Flavoplaca cranfieldii* (S.Y.Kondr. & Kärnefelt) Arup, Frödén & Søchting, Nordic J. Bot. 31: 45 (2013). — **Type:** Australia, Western Australia: 2.7 km S of Lynton Station ruin, 28°12'44"S 114°20'09"E, on ironstone/sandstone, often in shade of *Acacia ligulata* in pasture, 6 Jan. 2004, *S. Kondratyuk 20423, I. Kärnefelt & R.J. Cranfield* (holo.: PERTH; iso.: CANB!, HO!, MEL!).

Thallus composed of rather dispersed, adnate areoles, yellow to orange-yellow, becoming coarsely sorediate-blastidiate at the margins and on the upper surface; apothecia lecanorine (but with algal cells mainly towards the base of the margin), to 0.5 mm wide, basally constricted; margin and disc concolorous with the thallus; hymenium and subhymenium lightly inspersed with oil droplets; paraphyses lacking oil vacuoles but with apical cells enlarged to 4 µm; ascospores 8–15 × 4.5–6.5 µm; septum 3–5 µm.

On nutrient-enriched rocks, especially in the vicinity of animal pasture, bird rookeries or bird perch-sites; also on limestone in such sites and in coastal heathland.

*Selected specimens examined.* Stokes Bay, 35°37'S 137° 13'E, 50 m alt., 2012, *G. Kantvilas 520/12 & B. de Villiers* (AD, HO, KW); northern end of Antechamber Bay, 35°46'S 138°04'E, 5 m alt., 2013, *G. Kantvilas 269/13* (HO); Western River Cove, E of beach, 35°41'S 136° 58'E, 20 m alt., 2015, *G. Kantvilas 412/15* (AD, HO, KW).

***Caloplaca dahlii* Elix, S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 99: 267 (2009); *Eilifdahlia dahlii* (Elix, S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Kärnefelt, Elix, A.Thell, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 56: 110 (2014). — **Type:** Australia, New South Wales: Jimberoo State Forest, Mountain Creek, 11 km NNE of Rankins Springs, 33°45'S 146°19'E, 340 m alt., on dead *Callitris* on *Callitris*-dominated rocky ridge, 13 June 1990, *J.A. Elix 25276* (holo.: CANB!; iso.: MEL!).

Thallus crustose, indistinct or pale glaucous grey to beige-brown, containing lichexanthone; apothecia biatorine, to 1.5 mm wide, basally constricted; margin bright orange, orange-yellow or reddish orange, entire or lobed to markedly flexuose; disc concolorous, sometimes slightly pruinose; hymenium and subhymenium not inspersed; paraphyses lacking oil vacuoles, with apices sometimes slightly expanded to c. 3 µm; ascospores 12–17 × 5–9 µm; septum 4–7.5 µm. **Fig. 5A.**

On bark; very common and widely distributed. This is by far the most common epiphytic species of *Caloplaca* on the island.

*Selected specimens examined.* Red Banks, 35°45'S 137° 43'E, 2008, *G. Kantvilas 326/08* (AD, HO); Beyeria Conservation Park, 35°47'S 137°36'E, 50 m alt., 2010, *G. Kantvilas 211/10* (AD, HO); Brown Beach, 35°48'S 137° 50'E, 10 m alt., 2012, *G. Kantvilas 417/12 & B. de Villier*s (AD, HO).

***Caloplaca eos* S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 95: 355 (2007); *Sirenophila eos* (S.Y. Kondr. & Kärnefelt) Arup, Frödén & Søchting, Nordic J. Bot. 31: 63 (2013). — **Type:** Australia, New South Wales: S of Anna Bay, Tomaree National Park, 32°47'16"S 152°04'48"E, on rock (rhyolite outcrops) along the coast, 24 Jan. 2004, *I. Kärnefelt* 20044701*, R.B. Filson & S. Kondratyuk 20475* (holo.: CANB!; iso.: MEL!).

Thallus crustose, areolate, rather bullate and wrinkled centrally, minutely effigurate-lobed at the margins, yellow-orange to orange to orange-red, lacking any prothallus; apothecia biatorine, becoming ± zeorine, to 0.7 mm wide, basally constricted; thalline margin mostly incomplete and basal; proper margin and disc concolorous with the thallus or more intensely orange-red; hymenium not inspersed; subhymenium inspersed with abundant oil droplets; paraphyses very rarely with occasional oil vacuoles to c. 5 µm wide, and with apices not or only slightly enlarged to 3.5–4 µm; ascospores 10–13 × 5–7 µm; septum 3.5–5.5 µm.

On siliceous coastal rocks. Together with *C. gallowayi* and *C. sublobulata*, this species is one of the main contributors to the orange, red and yellow coloration of the littoral zone.

*Selected specimens examined.* Windmill Bay, 35°51'S 138°07'E, 2 m alt., 2013, *G. Kantvilas 237/13 & B. de Villiers* (HO); northern end of Antechamber Bay, 35°47'S 138°04'E, 1 m alt., 2011, *G. Kantvilas 389/11* (AD, HO, KW); Point Ellen, 36°00'S 137°11'E, 2 m alt., 2012, *G. Kantvilas 463/12 & B. de Villiers* (AD, HO, KW).

***Caloplaca erythrosticta* (Taylor) Zahlbr.**

Cat. Lich. Univ. 7: 116 (1930); *Lecanora erythrosticta* Taylor, J. Bot. (Hooker) 6: 161 (1847). — **Type:** Australia, Western Australia: Swan River, on bark, *J. Drummond* (holo.: FH; iso.: BM!).

Thallus subsquamulose-areolate; areoles contiguous or dispersed, ± effigurate, brownish orange, sorediate; soredia coarsely granular, concolorous with the thallus, mostly laminal and arising in erose, rather crater-like soralia, soon spreading across the thallus; apothecia (not seen in KI material) zeorine, mostly to 0.6 mm wide, basally constricted; thalline margin brownish orange, crenulate, chiefly basal, sometimes incomplete; proper margin and disc a deeper tone than the thallus, orange-red; hymenium and subhymenium not inspersed; paraphyses lacking oil vacuoles, with apices sometimes swollen to 3–4.5 µm; ascospores 11–15 × 5–6.5 µm; septum 3.5–6 µm.

On wood. The single, small specimen from KI is sterile, but the sorediate subsquamulose areoles match the type specimen, numerous herbarium specimens (chiefly from Western Australia) determined by S. Kondratyuk and the description of Kondratyuk et al. (2004). The descriptive notes on apothecia and ascospores are based on these specimens.

*Specimen examined.* [Rocky River area], 1940, *J.B. Cleland* (AD 59909, HO).

***Caloplaca ferdinandmuelleri* S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 100: 241 (2009); *Filsoniana ferdinandmuelleri* (S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Kärnefelt, A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 55: 271 (2013). — **Type:** Australia, Victoria: Melbourne, Royal Botanic Gardens, near "Temple of the Winds" and "Plant Craft Cottage", among "grey plants" and succulents, on volcanic rocks, 14 Feb. 2004, *S. Kondratyuk 204133* (holo.: CANB; iso.: MEL).

Thallus subsquamulose; squamules contiguous to rather dispersed, ± effigurate, dull brownish orange, sorediate at the margins and on the upper surface; soredia coarsely granular, concolorous with the thallus or in part greenish or yellowish; apothecia biatorine, becoming zeorine, to 0.7 mm wide, basally constricted; thalline margin incomplete; proper margin and disc concolorous with the thallus; hymenium and subhymenium not inspersed; paraphyses lacking oil vacuoles but with apices mostly swollen to 5 µm; ascospores 9–13 × 5–7 µm; septum 2–4.5 µm.

On siliceous rocks in mallee woodland; elsewhere this species has also been recorded from soil. Neither type specimen could be located. The Kangaroo Island specimen has few, rather juvenile apothecia, which may explain why its ascospores are rather smaller than those cited for the type and seen in other specimens [(11–) 13–17 (–18) × 6–8 (–10) µm: Kondratyuk et al. 2009b]. The morphology of the KI specimen matches other herbarium specimens very well. This species is probably the sorediate counterpart of *C. rexfilsonii.*

*Specimen examined.* Creek Bay Farm, 35°50'S 138°06'E, 85 m alt., 2013, *G. Kantvilas 370/13* (AD, HO).

***Caloplaca gallowayi* S.Y.Kondr., Kärnefelt & Filson**

Biblioth. Lichenol. 95: 358 (2007); *Sirenophila gallowayi* (S.Y.Kondr., Kärnefelt & Filson) Søchting, Arup & Frödén, Nordic J. Bot. 31: 63 (2013). — **Type:** Australia, Tasmania: W of Wynyard, Boat Harbour Beach, on coastal rocks, locally abundant, 40°55'57"S 145°37'07"E, 29 Jan. 1999, *I. Kärnefelt 997501* (holo.: CANB!; iso.: HO!, MEL!)

Thallus crustose, rimose-areolate, orange-red, often with a patchy, effuse, pale orange-red prothallus visible at the margins or between areoles; apothecia biatorine, sometimes becoming ± zeorine, to 0.5 mm wide, basally constricted, typically very abundant and crowded; thalline margin mostly incomplete and basal; proper margin and disc concolorous with the thallus; hymenium not inspersed; subhymenium inspersed with abundant oil droplets; paraphyses mostly slender, with oil vacuoles uncommon and apices sometimes expanded to 3.5 µm; ascospores 9–14 × 4–7 µm; septum 3.5–5.5 µm. **Fig. 3.**

This is the most common and conspicuous species in the littoral zone, responsible for the vivid reddish banding on siliceous coastal rocks. It may also extend slightly inland.

*Selected specimens examined.* Emu Bay, 35°35'S 137° 31'E, 1957, *H.B.S. Womersley* (AD); Cape St Albans, 35°48'S 138°08'E, 40 m alt., *G. Kantvilas 362/11* (AD, HO, KW); Stokes Bay, 35°37'S 137°13'E, 50 m alt., 2012, *G. Kantvilas 512/12 & B. de Villiers* (AD, HO, KW).

***Caloplaca gilfillaniorum* Kantvilas & S.Y.Kondr.**

J. Adelaide Bot. Gard. 26: 10 (2013); *Kaernefia gilfillaniorum* (Kantvilas & S.Y.Kondr.) S.Y.Kondr., A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 55: 272 (2013). — **Type:** Australia, South Australia: Kangaroo Island, Creek Bay Farm ('Carew'), 35°51'S 138°06'E, 100 m alt., on dead old mallee root in rough pasture, 25 Sep. 2011, *G. Kantvilas 417/11* (holo.: HO!; iso.: AD!, KW-L!).

Thallus composed of scattered, minute, isidioid granules to 0.1 mm wide, greyish green to greenish yellow or yellow; apothecia biatorine, soon becoming zeorine, to 1 mm wide, basally constricted; thalline margin pale greyish green; proper margin and disc yellow to orange-yellow; hymenium not inspersed; subhymenium with occasional oil droplets; paraphyses slender, with oil vacuoles uncommon, to 5 µm wide, and with apices sometimes expanded to 5 µm; ascospores 12–17 × 6–8.5 µm; septum 3–7 µm.

In dry, exposed habitats on wood in pasture, mallee woodland and dry sclerophyll forest. With further observations and collections of this species and its relative, *C. kaernefeltii*, I have grown increasingly uneasy about their distinctiveness, at least on Kangaroo Island, where the main points of difference (the sorediate thallus, broader, more orange apothecial disc and entire, lecanorine apothecial margin of the latter) are becoming

**Fig. 4.** ***Caloplaca jackelixii*** habit, showing the mottled orange, yellow and greyish thallus. Scale = 2 mm. Photo: B. de Villiers.

increasingly blurred. I am somewhat reassured that molecular studies by Kondratyuk et al. (2013) maintain their separation. However, it is possible that all Kangaroo Island collections of this complex are conspecific but distinct from the type specimen of *C. kaernefeltii*, which is from Western Australia. In that specimen, the subhymenium is not inspersed, oil vacuoles are frequent, and no ascospores are longer than 13 µm.

*Specimens examined.* Creek Bay Farm, 35°50'S 138°06'E, 70 m alt., 2013, *G. Kantvilas 225/13* (HO); Grassdale Lagoon, 36°00'S 136°53'E, 20 m alt., 2015, *G. Kantvilas 333/15 & B. de Villiers* (AD, HO, LD).

***Caloplaca holocarpa* (Hoffm.) A.E.Wade**

Lichenologist 3: 11 (1965); *Athallia holocarpa* (Hoffm.) Arup, Frödén & Søchting, Nordic J. Bot. 31: 36 (2013); *Verrucaria obliterata* var. *holocarpa* Hoffm., Deutschl. Fl., Zweiter Teil (Erlangen): 179 (1796). — **Type:** Germany: Herrenhausi, *Ehrhart*, Plantae Cryptogamae nr. 284 (lecto.: GOET, fide Arup 2009).

Thallus crustose, inconspicuous, dull greyish; apothecia biatorine, sometimes becoming zeorine, 0.1–0.3 mm wide, basally constricted, crowded together and dominating the thallus; thalline margin incomplete, basal; proper margin and disc yellow-orange; hymenium and subhymenium not inspersed; paraphyses lacking oil vacuoles, with apices becoming ± moniliform and expanded to 3–5 µm; ascospores 9–14 × 5–8 µm; septum 3–4 µm.

On nutrient-enriched rocks.

*Specimen examined.* Creek Bay Farm, 35°50'S 138°06'E, 85 m alt., 2013, *G. Kantvilas 376/13* (HO, KW).

***Caloplaca jackelixii* S.Y.Kondr., Kärnefelt & A.Thell**

Biblioth. Lichenol. 100: 251 (2009); *Sirenophila jackelixii* (S.Y.Kondr., Kärnefelt & A.Thell) Søchting, Arup & Frödén, Nordic J. Bot. 31: 63 (2013). — **Type:** Australia, Tasmania: far south-eastern Bass Strait, Cygnet Island, near Swan Island, c. 11 m WSW of the summit, 40°43'S 148°04'E, 1 m alt., on quartzite, 10 Apr. 1980, *J.S. Whinray 1549* (holo.: MEL!).

Thallus crustose, deeply rimose-areolate, mottled with yellowish, orange, pale grey and greenish grey tones, sometimes in ± concentric zones; apothecia at first biatorine, soon zeorine, to 0.9 mm wide, basally constricted, usually very numerous; thalline margin greyish, at first basal but soon enveloping the entire apothecium; disc bright orange-yellow to orange-red; proper margin concolorous with the disc or a little paler; hymenium and subhymenium not inspersed, or with occasional oil droplets in the latter; paraphyses usually with scattered oil vacuoles to 7 µm wide, and apices sometimes expanded to 3 µm; ascospores 9–13 × 5–6.5 µm; septum 3–4 µm. **Fig. 4.**

On siliceous coastal rocks, intermixed with other species of *Caloplaca*, but seemingly preferring more sheltered sites such as overhangs or the lee side of boulders. Whereas the thick, zoned or mottled thallus makes this species readily recognisable, anatomically it is variable and rather enigmatic. Kondratyuk et al. (2009b) emphasise the presence of conspicuous oil vacuoles in chains, but my observations suggest these are at best occasional in the type specimen, rather uncommon in collections from Kangaroo Island, but abundant in some

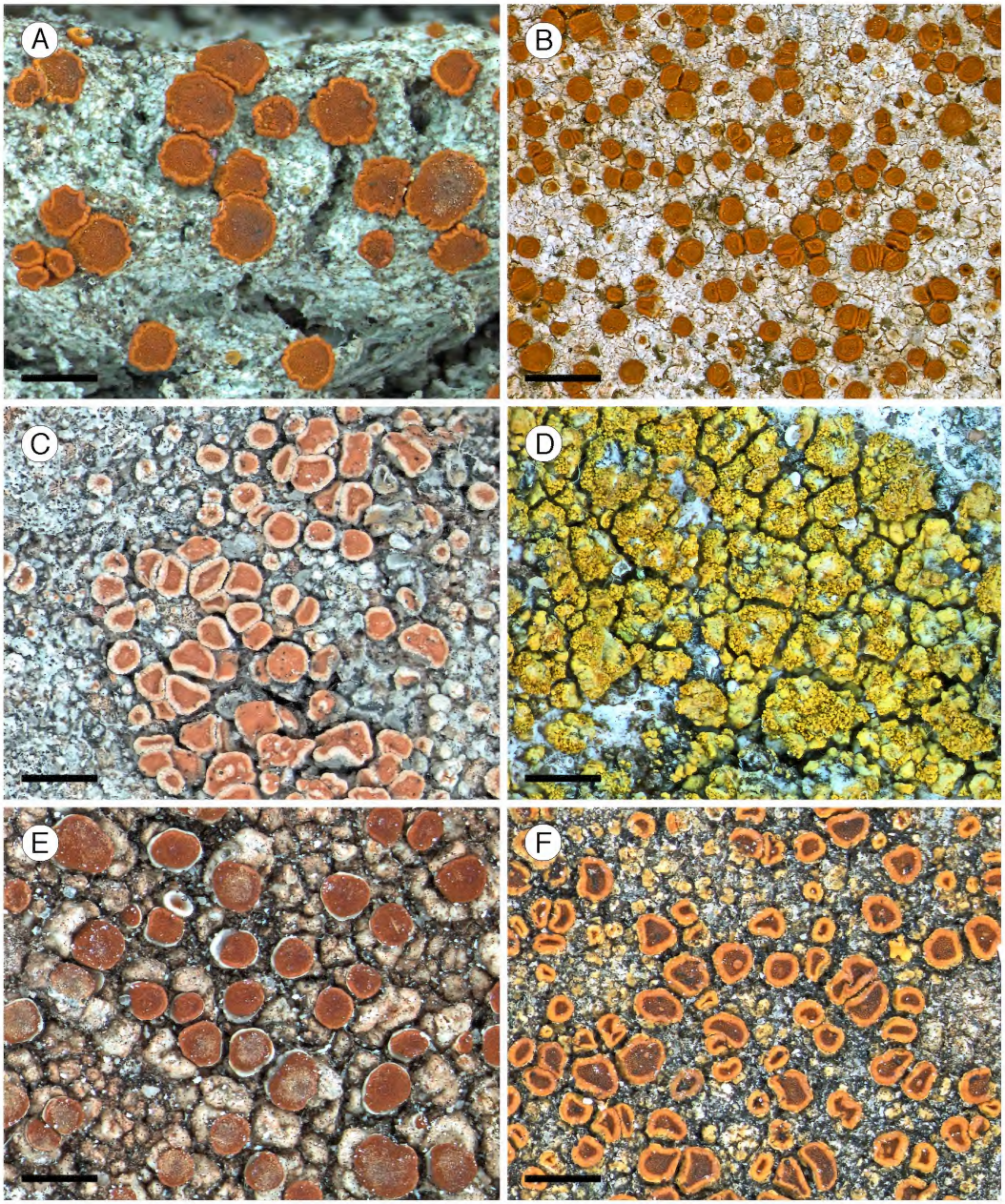


**Fig. 5.** Habit of ***Caloplaca*** species of Kangaroo Island. **A *C. dahlii***; **B *C. jerramungupensis***; **C *C. johnwhinrayi***; **D *C. kantvilasii***; **E *C. kilcundaensis***; **F *C. lateritia***. Scale = 1 mm.

Tasmanian collections. The presence of scattered oil droplets in the hypothecium is likewise variable.

*Specimens examined.* Cape St Albans, 35°48'S 138°07'E, 40 m alt., 2015, *G. Kantvilas 399/15* (AD, HO, KW); shoreline of Eastern Cove, c. 2.5 km NE of American River, 35°46'S 137°47'E, 3 m alt., 2015, *G. Kantvilas 491/15* (AD, HO, KW).

***Caloplaca jerramungupensis* S.Y.Kondr., Kärnefelt & Elix**

Biblioth. Lichenol. 99: 270 (2009); *Xanthocarpia jerramungupensis* (S.Y.Kondr., Kärnefelt & Elix) S.Y.Kondr., Kärnefelt, A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 55: 273 (2013). — **Type:** Australia, Western Australia: Shire of Jerramungup, Fitzgerald River, 21 km E of Jerramungup, 33°49'44"S 119°15'44"E, on sandy soil in scrub with *Melaleuca uncinata*, *Eucalyptus astringensis* and *Allocasuarina campestris* and granite outcrops, 10 Jan. 2004, *S. Kondratyuk 20444, E.I. Kärnefelt & R.J. Cranfield* (holo.: PERTH; iso.: CANB!).

Thallus crustose, inconspicuous, faintly rimose, pale yellowish grey to yellowish brown (K–); apothecia biatorine, rarely becoming zeorine, to 0.7 mm wide, basally constricted, usually crowded together, rather angular and dominating the thallus; thalline margin mostly basal, only very rarely completely enveloping the apothecium; proper margin and disc brownish orange; hymenium and subhymenium inspersed with oil droplets; paraphyses with occasional oil vacuoles to 7 µm wide in the uppermost parts, with apices typically expanded to 5 µm wide and ± moniliform; ascospores 14–18 × 6–9 µm; septum 1–4 µm. **Fig. 5B.**

On limestone outcrops in coastal heathland or in rough pasture near the coast. This species was first described (from Western Australia) from soil, but most herbarium specimens seen (from a range of geographical locations) are from calcareous rocks.

*Selected specimens examined.* Cape St Albans, 35°48'S 138°08'E, 40 m alt., 2011, *G. Kantvilas 359/11* (AD, HO, KW); Ravine des Casoars, at the coast, 35°48'S 136° 35'E, 5 m alt., 2012, *G. Kantvilas 454/12A* (HO, KW); near Pelican Lagoon, summit of hill above the Tiger Simpson memorial, 35°50'S 137°49'E, 60 m alt., 2013, *G. Kantvilas 287/13* (HO).

***Caloplaca johnwhinrayi* S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 100: 253 (2009). — **Type:** Australia, Tasmania: Bass Strait, Furneaux Group, West Sister Island, c. one-third of the way from W end of Southern Bay, c. 75 m inland, on S side of limestone bank, growing on small rocks and outcrops, together with *C. kantvilasii* and *C. jerramungupensis*, 15 Dec. 1966, *J.S. Whinray* (holo.: MEL!).

Thallus crustose, inconspicuous, scurfy-verruculose, greyish white; apothecia initially biatorine, usually soon zeorine, 0.4–1 mm wide, markedly basally constricted, crowded and dominating the thallus; thalline margin whitish, scabrid or coarsely pruinose; proper margin pale orange; disc pinkish orange, sometimes with a thin, whitish pruina; hymenium not inspersed; subhymenium inspersed with sparse oil droplets; paraphyses with scattered oil vacuoles to 7 µm wide, mostly occurring in pairs or short chains, and with apices mostly not expanded; ascospores 12–15 × 4.5–7 µm; septum 3–6 µm. **Fig. 5C.**

On limestone in coastal heathland and rough pasture.

*Specimens examined.* Stokes Bay, 35°37'S 137°13'E, 50 m alt., 2012, *G. Kantvilas 518/12 & B. de Villiers* (AD, HO, KW); Windmill Bay 35°51'S 138°07'E, 20 m alt., 2012, *G. Kantvilas 475/12* (AD, HO, KW); Cape Willoughby, 35°51'S 138°08'E, 10 m alt., 2013, *G. Kantvilas 242/13 & B. de Villiers* (HO).

***Caloplaca kaernefeltii* S.Y.Kondr., Elix & A.Thell**

Biblioth. Lichenol. 100: 254 (2009); *Kaernefia kaernefeltii* (S.Y.Kondr., Elix & A.Thell) S.Y.Kondr., A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 55: 273 (2013). — **Type:** Australia, Western Australia: at edge of Lake Chittering, 31°25'01"S 116°05'39"E, on *Melaleuca rhaphiophylla* and *Eucalyptus rudis*, 3 Jan. 2004, *S. Kondratyuk 20407, I. Kärnefelt & R.J. Cranfield* (holo.: PERTH; iso.: CANB!, MEL!, HO!).

Thallus composed of dispersed greyish green to orange-yellow granules that become ± sorediate; apothecia lecanorine, sometimes biatorine to zeorine, to 1 (–2) mm wide, basally constricted; thalline margin whitish, scabrid; proper margin and disc orange to orange-pink; hymenium and subhymenium not inspersed; paraphyses with scattered oil vacuoles to 6 µm wide, and with apices sometimes expanded to 3.5 µm; ascospores 11.5–16 × 5.5–8 µm; septum 3.5–6 µm.

On soft, moist bark in swampy woodland. Distinguishing this species from its relative, *C. gilfillaniorum*, is discussed above under that species, including the possibility that Kangaroo Island collections are distinct from the Type collection.

*Specimens examined.* Chapman River, 35°48'S 138°04'E, 2 m alt., 2011, *G. Kantvilas 371/11 & B. de Villiers* (HO, KW); Ravine des Casoars, 35°48'S 136°35'E, 15 m alt., 2012, *G. Kantvilas 483/12 & B. de Villiers* (AD, HO); the old Cannery, American River, c. 1 km SW of Ballast Head, 35°46'S 137°48'E, 3 m alt., 2013, *G. Kantvilas 348/13 & B. de Villiers* (AD, HO).

***Caloplaca kalbiorum* S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 96: 158 (2007); *Marchantiana kalbiorum* (S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Kärnefelt, Elix, A.Thell, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 56: 111 (2014); *Streimanniella kalbiorum* (S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Kärnefelt, A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 57: 340 (2015). — **Type:** Australia, Western Australia: c. 5 km SE of Katanning, on roadside *Casuarina*, 250 m, 33°40'S 117°38'E, 16 Aug. 1994, *K. & A. Kalb 33828* (holo.: PERTH).

Thallus crustose, rimose-areolate, glaucous grey, sorediate, containing lichexanthone; soralia scattered, ± erose, to 0.3 mm wide, bluish grey; apothecia biatorine, to 0.6 mm wide, basally constricted, scattered, black, lacking anthraquinone pigments but with the outermost parts with a blue-green, N+ crimson pigment; hymenium not inspersed; subhymenium densely inspersed with oil droplets; paraphyses slender, lacking oil vacuoles, with apices sometimes expanded to 3.5 µm; ascospores 10–15 × 5–8 µm; septum 4–6 µm.

On the bark of an old *Leucopogon* shrub at the edge of an abandoned paddock. With its black apothecia that lack any of the orange or yellow pigments characteristic for the genus, this species is unique in the *Caloplaca*

flora of KI. Superficially it looks like a species of *Buellia*, from which it is instantly distinguished by its hyaline, polaribilocular ascospores and *Teloschistes*-type asci.

*Specimen examined.* Hanson Bay Track, c. 1 km S of Grassdale Homestead, 36°00'S 136°52'E, 5 m alt., 2015, *G. Kantvilas 368/15 & B. de Villiers* (AD, HO).

***Caloplaca kantvilasii* S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 95: 363 (2007); *Flavoplaca kantvilasii* (S.Y.Kondr. & Kärnefelt) Arup, Frödén & Søchting, Nordic J. Bot. 31: 45 (2013). — **Type:** Australia, Western Australia: Cape Burney, Greenough River Mouth, 28° 42'2"S 114°38'10"E, on sandy limestone, 5 Jan. 2004, *S. Kondratyuk 20418a, I. Kärnefelt & R.J. Cranfield* (holo.: PERTH; iso.: CANB, MEL!).

Thallus subsquamulose, pale greyish to greenish yellow; individual squamules c. 1 mm thick, scattered, or crowded and separated by deep cracks, convex, plicate or effigurate, developing greenish yellow to yellow soredia from the underside of the margins, eventually disintegrating into soredia; apothecia lecanorine to zeorine, to 0.7 mm wide, nestled amongst the soredia; thalline margin greyish yellow, sorediate; disc and proper margin bright orange; hymenium and subhymenium inspersed with scattered oil droplets, the former rather sparingly; paraphyses lacking oil vacuoles but with apices becoming rather moniliform and expanded to c. 5 µm; ascospores 8–15 × 4–6 µm; septum 2–5 µm. **Fig. 5D.**

On limestone outcrops in coastal pasture and heathland. Fertile specimens are uncommon, and apothecia on most specimens studied belong to other species growing in very close association.

*Selected specimens examined.* Windmill Bay, 35°51'S 138°07'E, 20 m alt., 2012, *G. Kantvilas 472/12* (HO, KW); North Cape area, 3 km N of Cape Rouge, 35°35'S 137°38'E, 10 m alt., 2013, *G. Kantvilas 251/13* (AD, HO, KW); near Pelican Lagoon, summit of hill above the Tiger Simpson memorial, 35°50'S 137°49'E, 60 m alt., 2013, *G. Kantvilas 288/13* (HO, KW).

***Caloplaca kilcundaensis* S.Y.Kondr. & Kärnefelt**

Biblioth. Lichenol. 100: 256 (2009); *Franwilsia kilcundaensis* (S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Kärnefelt, Elix, A.Thell, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 56: 111 (2014). — **Type:** Australia, Victoria: Kilcunda, South Gippsland, on sandstone rocks along the shore, 38°33'9"S 145°28'43"E, 12 Feb, 2004, *I. Kärnefelt 20047101 & S. Kondratyuk* (holo.: CANB!; iso.: MEL!, HO!).

Thallus crustose, rimose-areolate, sometimes verruculose, pale brown to brownish grey, containing lichexanthone; apothecia biatorine, sometimes becoming zeorine to lecanorine, to 1.2 mm wide, basally constricted; thalline margin pale grey; proper margin and disc rusty orange-brown, the former often excluded as the disc becomes markedly convex; hymenium and subhymenium densely inspersed with oil droplets; paraphyses lacking oil vacuoles, with apices sometimes expanded to 3.5–4 µm; ascospores 11–18 × 5–7 µm; septum 1–3 µm. **Fig. 5E.**

On coastal rocks, mostly in habitats subject to nutrient enrichment from birds.

*Selected specimens examined.* Point Ellen, 36°00'S 137° 11'E, 4 m alt., 2007, *R.W. Rogers 15515* (BRI, HO); northern end of Antechamber Bay, 35°47'S 138°04'E, 5 m alt., 2011, *G. Kantvilas 395/11* (AD, HO, KW); Stokes Bay, 35°37'S 137°13'E, 50 m alt., 2012, *G. Kantvilas 519/12 & B. de Villiers* (HO, KW).

***Caloplaca lateritia* (Taylor) Zahlbr.**

Cat. Lich. Univ. 7: 154 (1930); *Lecidea lateritia* Taylor, J. Bot. (Hooker) 6: 149 (1847). — **Type:** Australia, Western Australia: Swan River, *J. Drummond* (holo.: FH!).

Thallus crustose, composed of discrete, rather scattered, sometimes inconspicuous, brownish orange areoles to c. 0.5 (–1) mm wide; apothecia biatorine, sometimes becoming zeorine, to 0.8 (–1) mm wide, basally constricted, scattered or crowded and then rather angular; thalline margin developing from the base, usually incomplete, crenulate when well developed; proper margin and disc rusty brownish orange, ± concolorous with the thallus; hymenium not inspersed; subhymenium usually inspersed with small oil droplets; paraphyses lacking oil vacuoles, becoming branched, ± moniliform and to 3.5 µm thick at the apices; ascospores 12–20 × 5.5–9.5 µm; septum 2.5–5 µm. **Fig. 5F.**

Widespread on siliceous rocks along the coast and in rough pasture, heathland and dry sclerophyll forest. This is a very variable species with respect to the size of the apothecia, the anatomy of the apothecial margin, and degree of inspersion of the subhymenium. The type specimen has somewhat larger apothecia than seen on KI (to 1.2 µm), zeorine apothecia with a ± complete, crenulate, thalline margin, and a non-inspersed subhymenium, but all specimens studied have the same distinctive ellipsoid ascospores with a relatively wide septum, and I am confident that they are conspecific.

Another related species (also mentioned by Kondratyuk et al. 2012) is *C. scarlatina* Zahlbr., described from New Zealand. However, this species has a more continuous, rimose-areolate thallus, and rather broader, squatter ascospores, 12–14 × 7–9 µm, with the septum 4–5 µm thick (isotype in CHR examined). Also related is *C. rexfilsonii* (see below) which has the same apothecial anatomy and ascopore dimensions as *C. lateritia*, but differs by its squamulose thallus. It is possible that *C. lateritia* and *C. rexfilsonii* represent extremes of a morphological continuum and should be synonymised, although I had little difficulty assigning the specimens studied to one or other taxon.

*Selected specimens examined.* c. 2 km SW of Cape St Albans, 35°49'S 138°07'E, 60 m alt., 2011, *G. Kantvilas 353/11* (HO, KW); c. 3.5 km NE of Stokes Bay, 35°37'S 137°13'E, 50 m alt., 2012, *G. Kantvilas 537/12* (HO, KW); Billygoat Falls, 35°42'S 136°55'E, 200 m alt., 2012, *G. Kantvilas 759/12 & B. de Villiers* (HO, KW).

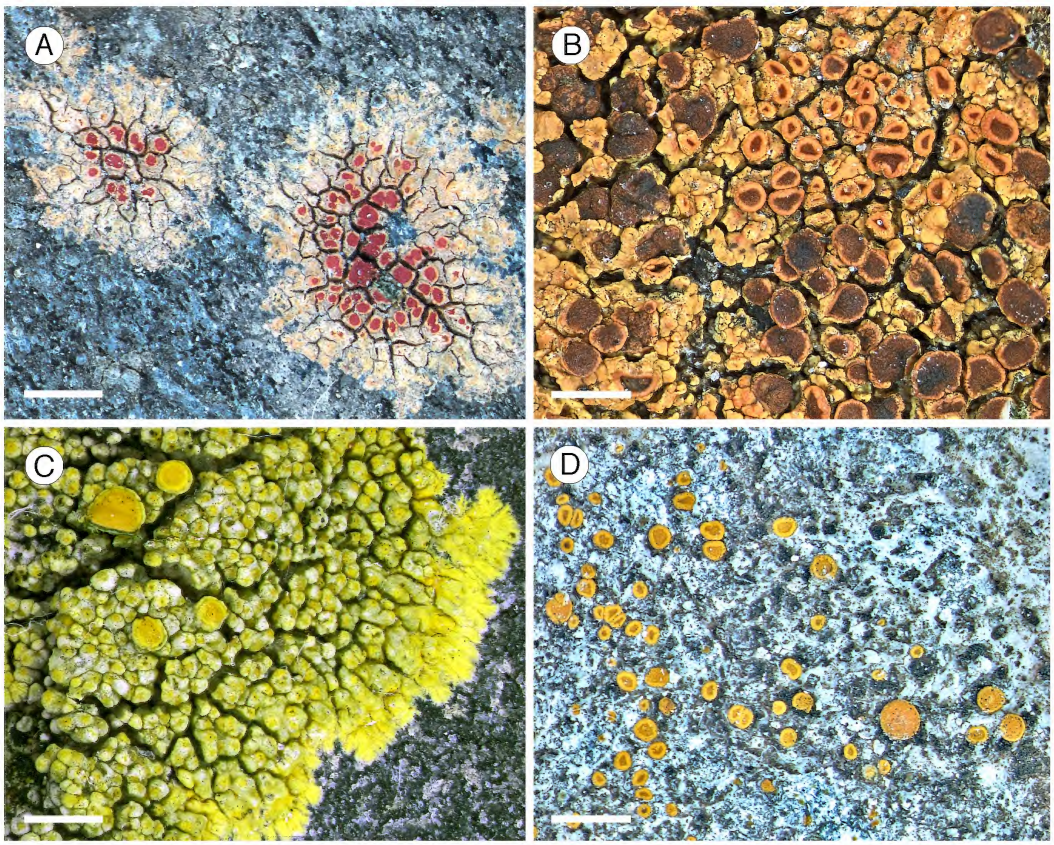


**Fig. 6.** Habit of ***Caloplaca*** species of Kangaroo Island. **A *C. montisfracti***; **B *C. rexfilsonii***; **C *C. sublobulata***; **D *C. yorkensis***. Scale = 1 mm.

***Caloplaca maccarthyi* S.Y.Kondr., Kärnefelt & Elix**

Biblioth. Lichenol. 100: 258 (2009); *Sirenophila maccarthyi* (S.Y.Kondr., Kärnefelt & Elix) Arup, Frödén & Søchting, Nordic J. Bot. 31: 63 (2013). — **Type:** Australia, Victoria: Port Welshpool, 22 km E of Foster, on trees near the shore, 38°42'00"S 146°28'01"E, 12 Nov. 1997, *I. Kärnefelt 977801* (holo.: CANB!; iso.: HO!, MEL!).

Thallus crustose, rather scurfy, grey to green-grey; apothecia soon becoming lecanorine to zeorine, to 0.5 mm wide, semi-immersed to sessile; thalline margin greyish; proper margin and disc yellow, sometimes discoloured pale orange-brown; hymenium and subhymenium not inspersed; paraphyses usually with scattered oil vacuoles to 6 µm wide, sometimes forming chains, and with apices not markedly expanded; ascospores 10–15 × 5–8 µm; septum 4–6 µm.

On the bark and wood of shrubs in heathland and mallee.

*Selected specimens examined.* Cape St Albans, 35°48'S 138°07'E, 90 m alt., 2011, *G. Kantvilas 357/11* (HO, KW); northern end of Antechamber Bay, 35°46'S 138°04'E, 5 m alt., 2013, *G. Kantvilas 274/13* (HO); Red House Bay, 35°49'S 138°06'E, 15 m alt., 2013, *G. Kantvilas 321/13* (HO).

***Caloplaca mereschkowskiana* S.Y.Kondr. & Kärnefelt**

in Lumbsch et al., Phytotaxa 18: 33 (2011); *Flavoplaca mereschkowskiana* (S.Y.Kondr. & Kärnefelt) Arup, Frödén & Søchting, Nordic J. Bot. 31: 46 (2013). — **Type:** Australia, Western Australia: N of Northampton, road to Horrocks, Bower River Rd, on calcareous rock, 28°24'S 114°27'E, Jan. 2004, *I. Kärnefelt 20041503, S. Kondratyuk & R.J. Cranfield* (holo.: PERTH; iso.: CANB!).

Thallus crustose, scurfy, pale greyish, more commonly inconspicuous to absent; apothecia biatorine, to 0.6 mm wide, basally constricted, dominating the thallus, rarely with an incipient thalline margin developing at the base; disc orange-yellow to orange or reddish orange; proper margin concolorous, rarely becoming excluded; hymenium not inspersed; subhymenium mostly not inspersed; paraphyses lacking oil vacuoles, with apices only slightly expanded to c. 3 µm; ascospores 9–13 × 5–7 µm; septum 1.5–3 µm.

**Fig. 7.** ***Caloplaca tomareeana*** habit. Scale = 5 mm.

On limestone outcrops in coastal heathland and rough pasture.

*Specimens examined.* Windmill Bay, 35°51'S 138°07'E, 20 m alt., 2012, *G. Kantvilas 474/12* (AD, HO, KW); near Pelican Lagoon, summit of hill above the Tiger Simpson memorial, 35°50'S 137°49'E, 60 m alt., 2013, *G. Kantvilas 289/13* (HO).

### *Caloplaca montisfracti* S.Y.Kondr. & Kärnefelt

Biblioth. Lichenol. 95: 370 (2007); *Brownliella montisfracti* (S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Kärnefelt, A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 55: 271 (2013); *Neobrownliella montisfracti* (S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Elix, Kärnefelt & A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 57: 340 (2015). — **Type:** Australia, Western Australia: N of Northampton, road to Port Gregory, on sandstone-ironstone rocks, 28°12'41"S 114°20'9"E, 6 Jan. 2004, *I. Kärnefelt 20041703, S. Kondratyuk & R.J. Cranfield* (holo.: PERTH; iso.: CANB!).

Thallus crustose, rimose-areolate, very tightly adnate, greyish pink to pale orange-pink, forming discrete round spots to 10 mm wide; apothecia ± aspicilioid, immersed, to 0.3 mm wide, crowded together and rather angular; disc pinkish red; margin thin, pale orange; hymenium and subhymenium not inspersed; paraphyses lacking oil vacuoles, with apices to 3 µm wide, not significantly expanded; ascospores 7–11 × 4.5–6 µm; septum 1.5–3 µm. **Fig. 6A.**

In rather sheltered underhangs on siliceous rocks in rough pasture.

*Specimen examined.* c. 2 km SW of Cape St Albans, 35° 49'S 138°07'E, 60 m alt., 2011, *G. Kantvilas 355/11* (AD, HO, KW).

### *Caloplaca piscatorica* Kantvilas & S.Y.Kondr.

J. Adelaide Bot. Gard. 26: 12 (2013). — **Type:** Australia, South Australia: Kangaroo Island, northern end of Antechamber Bay, 35°47'S 138°04'E, 0 m alt., on seashore rocks in underhangs and crevices, 18 Sep. 2012, *G. Kantvilas 510/12* (holo.: HO!; iso.: AD!, KW!).

Thallus crustose, not apparent to absent; apothecia biatorine, to 0.6 mm wide, basally constricted; proper margin and disc bright lemon-yellow; hymenium and subhymenium not inspersed; paraphyses lacking oil vacuoles, with apices sometimes enlarged to 3–4 µm; ascospores 7.5–11 × 4–5 µm; septum 0.5–2.5 µm.

On siliceous sea-shore rocks, mostly in sheltered microhabitats.

*Specimens examined.* Northern end of Antechamber Bay, 35°47'S 138°04'E, 2011, *G. Kantvilas 489/11* (HO, LD, KW); Ravine des Casoars, c. 0.5 km inland from coast, 35°48'S 136°35'E, 15 m alt., 2012, *G. Kantvilas 481/12 & B. de Villiers* (AD, HO, KW).

### *Caloplaca rexfilsonii* S.Y.Kondr. & Kärnefelt

Biblioth. Lichenol. 95: 371 (2007); *Filsoniana rexfilsonii* (S.Y.Kondr., Kärnefelt & Filson) S.Y.Kondr., Kärnefelt, A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 55: 272 (2013). — **Type:** Australia, New South Wales: Kiama, Coronation Park, 34°40'39"S 115° 51'18"E, on rock outcrops along the coast, 27 Jan. 2004, *S. Kondratyuk 20480* (holo.: CANB!, iso.: BM!, HO!, MEL!).

Thallus squamulose, rusty brownish orange; squamules dispersed or, more commonly, imbricate, sometimes with ± effigurate margins; apothecia at first biatorine, usually soon becoming zeorine, to 1.2 mm wide, sessile to basally constricted; thalline margin cre-

nulate, sometimes incomplete; disc dark rusty brownish orange; proper margin concolorous with the disc or slightly paler; hymenium not inspersed; subhymenium sometimes inspersed with a few oil droplets; paraphyses lacking oil vacuoles, with apices usually becoming ± moniliform and expanded to 3.5 µm; ascospores 12–18 × 6–9 µm; septum 2–6 µm. **Fig. 6B.**

On siliceous rocks near the coast; also collected from consolidated soil in a gap in mallee woodland where it grew together with *Psora decipiens* and species of *Endocarpon*. This species appears to be closely related to *C. lateritia* and may possibly represent a form of that species with a very well-developed thallus. When growing on rocks, the two species frequently co-occur and have identical apothecial anatomy and ascospores.

*Selected specimens examined.* Northern end of Antechamber Bay, 35°47'S 138°04'E, 5 m alt., 2013, *G. Kantvilas 266/13* (AD, HO); Cape St Albans, 35°48'S 138°07'E, 40 m alt., 2015, *G. Kantvilas 396/15* (HO, KW); Lashmar Conservation Park, c. 2 km S of Cape Coutts, 35°47'S 138°04'E, 50 m alt., 2015, *G. Kantvilas 428/15 & B. de Villiers* (HO).

### *Caloplaca sublobulata* (Nyl.) Zahlbr.

Cat. Lich. Univ. 7: 267 (1931); *Gondwania sublobulata* (Nyl.) S.Y.Kondr., Kärnefelt, Elix, A.Thell, J.Kim, M.-H. Jeong, N.N.Yu, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 56: 164 (2014). — **Type:** [Argentina] Fuegia, Staten Island, 1882, *Spegazzini* (holo.: H-Nyl 30655).

Thallus crustose, rimose-areolate, soon becoming rather papillate to subfruticose, bright yellow, typically surrounded by a yellow, spidery to effigurate prothallus; apothecia biatorine to zeorine, to 1.1 mm wide, basally constricted; proper margin and disc concolorous with the thallus; hymenium not inspersed; subhymenium usually inspersed with small oil droplets; paraphyses lacking oil vacuoles, with apices expanded to 4 µm; ascospores 10–14 × 5–7 µm; septum 2.5–4 µm. **Fig. 6C.**

On siliceous coastal rocks, often in the vicinity of bird roosting sites, typically forming mosaics with the orange to orange-red species, *C. eos*, *C. gallowayi* and *C. jackelixii*. This name is based on a South American type and has been widely applied across the Southern Hemisphere (Søchting & Øvstedal 1992), including South Australia (Santesson 1944). Published descriptions cite somewhat larger ascospores; for example, 14–16 × 7–8 µm (Søchting & Øvstedal 1992), 13–15 (–18) × 5–6 (–7) µm (Galloway 2007) and 12–17 × 6.5–8.5 µm (Santesson 1944). However, this discrepancy could be due to KI specimens having few well-developed asci containing mature ascospores, despite being seemingly well-fertile. In the event that not all Southern Hemisphere populations are deemed to be conspecific, two names based on Australasian types could be available: *C. conranii* S.Y.Kondr. & Kärnefelt, described from Victoria (holotype in CANB examined), and *C. circumlutosa* Zahlbr., described from New Zealand (isolectotype in CHR examined).

*Selected specimens examined.* Windmill Bay, 35°51'S 138°07'E, 2 m alt., 2012, *G. Kantvilas 495/12* (AD, HO, KW); the old Cannery, American River, c. 1 km SW of Ballast Head, 35°46'S 137°48'E, 0.5 m alt., 2013, *G. Kantvilas 340/13 & B. de Villiers* (HO, KW); Cape St Albans, 35°48'S 138°07'E, 2 m alt., 2013, *G. Kantvilas 213/13 & B. de Villiers* (AD, HO, KW).

### *Caloplaca subluteoalba* S.Y.Kondr. & Kärnefelt

Biblioth. Lichenol. 100: 269 (2009); *Cerothallia subluteoalba* (S.Y.Kondr. & Kärnefelt) Arup, Frödén & Søchting, Nordic J. Bot. 31: 40 (2013). — **Type:** Australia, Victoria: Port Fairy, western part of the shore, 38°23'34"S 142°13'41"E, 29 km W of Warnambool, on shrubs above the shore, 14 Nov. 1997, *I. Kärnefelt 978206* (holo.: CANB!; iso.: HO!, MEL!).

Thallus crustose, scurfy and inconspicuous, or endophloeodal; apothecia biatorine, sometimes with an incipient thalline margin at the base, to 0.5 mm wide, sessile; proper margin and disc bright yellow; hymenium not inspersed; subhymenium inspersed with occasional oil droplets; paraphyses lacking oil vacuoles but with the uppermost cells sometimes expanded to 4 µm; ascospores 7.5–11 × 4–6 µm; septum 0.5–2 µm.

On bark and wood in coastal heathland.

*Specimens examined.* W of Windmill Bay, 35°51'S 138° 07'E, 40 m alt., 2012, *G. Kantvilas 498/12A & 500/12* (HO, KW).

### *Caloplaca tibellii* S.Y.Kondr. & Kärnefelt

Biblioth. Lichenol. 100: 269 (2009). — **Type:** Australia, Western Australia: Porongorups National Park, 21 km ESE of Mount Barker, 0.2 km E of Hayward Peak, 34°41'S 117°53'E, 520 m [alt.]., on decaying bark of *Eucalyptus*, 13 Oct. 1983, *L. Tibell 14157*; distributed through *Lich. Sel. Exsicc. Upsalienses 2* as *Caloplaca citrina* (holo.: CANB!; iso.: BM!).

Thallus inconspicuous, endophloeodal, detected as scattered, granular clusters of bright lemon-yellow soredia; apothecia biatorine, to 0.6 mm wide, basally constricted; disc yellow-orange; proper margin concolorous, sometimes becoming excluded; hymenium not inspersed; subhymenium sometimes inspersed with minute oil droplets; paraphyses with scattered oil vacuoles to 5–8 µm wide occurring in chains or pairs, and with apices sometimes expanded to 3.5–4 µm; ascospores 8–15 × 4–7 µm; septum 3–6.5 µm.

On bark in heathland. Kondratyuk et al. (2009b) cite somewhat larger ascospores, 13–16 × 5–7 (–9) µm with the septum 5–7 (–9) µm thick, but these dimensions were not confirmed by examination of the type collection, nor specimens from Kangaroo Island.

*Specimens examined.* West Bay, 35°53'S 136°33'E, 40 m alt., 1994, *H.T. Lumbsch 10920e, A. Dickhäuser & H. Streimann* (CANB, HO); W of Windmill Bay, 35°51'S 138°07'E, 40 m alt., 2012, *G. Kantvilas 498/12B* (HO).

### *Caloplaca tomareeana* S.Y.Kondr. & Kärnefelt

Biblioth. Lichenol. 95: 379 (2007); *Sirenophila tomareeana* (S.Y.Kondr. & Kärnefelt) Arup, Frödén & Søchting, Nordic J. Bot. 31: 64 (2013); *Tarasginia tomareeana*

(S.Y.Kondr. &, Kärnefelt) S.Y.Kondr., Kärnefelt, A.Thell, Elix, J.Kim, A.S.Kondr. & J.-S.Hur, Acta Bot. Hungarica 57: 340 (2015). — **Type:** Australia, New South Wales: S of Anna Bay, Tomaree National Park, 32°47'16"S 152° 04'48"E, on rock (rhyolite) outcrops along the coast, 24 Jan. 2004, *S. Kondratyuk 20474, R.B. Filson & I. Kärnefelt* (holo.: CANB!; iso.: MEL!).

Thallus subfoliose-placodioid, bullate-areolate centrally, with radiating, plicate, convex to plane, marginal lobes 0.3–0.8 mm wide, greenish yellow to yellowish orange; apothecia zeorine to lecanorine, to 1.2 mm wide, basally constricted; proper margin and disc orange to orange-red; hymenium not inspersed; subhymenium inspersed with minute oil droplets; paraphyses lacking oil vacuoles, with apices to 3.5 µm wide but generally not expanded; ascospores 9–14 × 5–6 µm; septum 3.5–7 µm. **Fig. 7.**

On hard, siliceous coastal rocks, especially on granite. Kondratyuk et al. (2007) also described another placodioid species, *C. whinrayi* S.Y.Kondr. & Kärnefelt, which they claimed differs from *C. tomareeana* chiefly by having thinner, plane rather convex marginal lobes. However, Arup et al. (2013) suggested that these two taxa are conspecific, based on their having identical ITS sequences. More recently, in a molecular analysis, Kondratyuk et al. (2015) referred two Kangaroo Island collections to *Tarasginia whinrayi* (≡ *C. whinrayi*), but given that no new material of *C. tomareeana* was included in that analysis, and the single sequence of that species was nested within *C. whinrayi*, the controversy remains unresolved. My observations of herbarium collections and populations in the field suggest that a single, morphologically variable species is involved.

*Selected specimens examined.* Point Ellen, 36°00'S 137° 10'E, 10 m, 2007, *R.W. Rogers 15518A* (BRI, HO); W of Windmill Bay, 35°51'S 138°07'E, 40 m alt., 2012, *G. Kantvilas 506/12A* (AD, HO); Cape St Albans, 35°48'S 138°07'E, 2 m alt., 2013, *G. Kantvilas 211/13 & B. de Villiers* (AD, HO).

### *Caloplaca wilsonii* S.Y.Kondr. & Kärnefelt

Biblioth. Lichenol. 100: 271 (2009). *Blastenia circumpolaris* Søchting, Frödén & Arup, Nordic J. Bot. 31: 67 (2013). — **Type:** Australia, Victoria: Mt Macedon, 1886, *F.R.M. Wilson 716* (lecto.: NSW!; isolecto.: HO!).

Thallus crustose, pale greyish, very thin to endophloeodal, detected by the scattered, roundish, crater-like, yellow or orange-yellow soralia 0.2–0.3–(0.5) mm wide; apothecia (not seen in KI material) biatorine, to 0.5 mm wide, basally constricted; disc orange to orange-brown, sometimes a little yellowish-pruinose; proper margin yellow-orange to orange; hymenium and subhymenium not inspersed; paraphyses lacking oil vacuoles, with apices not markedly expanded; ascospores 10–15 × 5–7 µm; septum 3–5.5 µm.

On eucalypt bark in dry sclerophyll forest. Descriptive notes on apothecia and ascospores given above are based on Tasmanian collections held in HO.

*Specimen examined.* Billygoat Falls, 35°42'S 136°55'E, 200 m alt., 2012, *G. Kantvilas 775/12* (HO).

### *Caloplaca yorkensis* S.Y.Kondr. & Kärnefelt

in Lumbsch et al., Phytotaxa 18: 34 (2011); *Cerothallia yorkensis* (S.Y.Kondr. & Kärnefelt) Arup, Frödén & Søchting, Nordic J. Bot. 31: 40 (2013). — **Type:** Australia, South Australia: Yorke Peninsula, Coodowie, 5 km E of Edithburgh along the coast, 35°03'S 137°44'E, on calcareous rocks, Jan. 1999, *I. Kärnefelt 995207* (holo.: CANB).

Thallus crustose, inconspicuous, endolithic or absent, rarely composed of brownish grey areoles; apothecia biatorine, to 0.5 mm wide, basally constricted; disc yellow, sometimes discoloured greyish; proper margin yellow; hymenium not inspersed; subhymenium inspersed with oil droplets; paraphyses lacking oil vacuoles, slender, with apices sometimes expanded to 2.5–3 µm; ascospores 8–11 × 3.5–5 µm; septum 0.5–3 µm. **Fig. 6D.**

On limestone in coastal heathland, typically in close association with *C. mereschkowskiana* and *C. jerramungupensis*, both of which are distinguished macroscopically by their more orange apothecia.

*Selected specimens examined.* Point Ellen, 36°00'S 137°-11'E, 5 m alt., 2012, *G. Kantvilas 458/12 & B. de Villiers* (AD, HO, KW); Windmill Bay 35°51'S 138°07'E, 20 m alt., 2012, *G. Kantvilas 473/12* (AD, HO, KW); Ravine des Casoars, at the coast, 35°48'S 136°35'E, 5 m alt., 2012, *G. Kantvilas 454/12* (HO, KW).

## Acknowledgements

I am deeply indebted to my friend and colleague of many years, Sergey Kondratyuk, who examined and commented on many specimens over several years, and imparted much of his experience of Australian *Caloplaca* species through extensive correspondence. The hospitality of the curators of various herbaria that were visited in the course of this study is also greatly appreciated, especially at AD, BM, CANB and MEL. Holger Thüss is thanked for so promptly sectioning and providing photographs of one critical specimen on request. Special thanks are due to Jean Jarman who photographed the species featured in Figures 1–2 and 5–6, and prepared all the photographic plates for publication. The encouraging comments of two anonymous referees on the penultimate version of this manuscript were greatly appreciated.

## References

Arup, U. (2009). The *Caloplaca holocarpa* group in the Nordic countries, except Iceland. *Lichenologist* 41: 119–130.

Arup, U., Søchting, U. & Frödén, P. (2013). A new taxonomy of the family Teloschistaceae. *Nordic Journal of Botany* 31: 16–83.

Galloway, D.J. (2007). *Flora of New Zealand Lichens*. Rev. 2nd edn. (Manaaki Whenua Press: Lincoln).

Gaya, E., Högnabba, F., Holguin, Á., Molnar, K., Fernández-Brime, S., Stenroos, S., Arup, U., Søchting, U., Van den Boom, P., Lücking, R., Sipman, H.J.M. & Lutzoni, F. (2012). Implementing a cumulative supermatrix approach for a comprehensive phylogenetic study of the Teloschistales (Pezizomycotina, Ascomycota). *Molecular Phylogenetics and Evolution* 63: 374–387.

Gaya, E., Fernández-Brime, S., Vargas, R., Lachlan, R.F., Gueidan, C., Ramírez-Mejía, M. & Lutzoni, F. (2015). The adaptive radiation of lichen-forming Teloschistaceae is associated with sunscreening pigments and a bark-to-rock substrate shift. *Proceedings of the National Academy of Sciences* 112: 11600–11605.

Kantvilas, G. & Kondratyuk, S.Y. (2013). New species of *Caloplaca* (lichenised Ascomycota: Teloschistaceae) from Kangaroo Island. *Journal of the Adelaide Botanic Gardens* 26: 9–14.

Kärnefelt, I. & Kondratyuk, S.Y. (2004). New species of *Caloplaca* (Teloschistaceae) from Australia. *Bibliotheca Lichenologica* 88: 255–265.

Kondratyuk, S.Y., Kärnefelt, I., Elix, J.A. & Thell, A. (2007a). New species of the genus *Caloplaca* in Australia. *Bibliotheca Lichenologica* 95: 341–386.

Kondratyuk, S.Y., Kärnefelt, I., Elix, J.A. & Thell, A (2007b). Contributions to the Teloschistaceae of Australia. *Bibliotheca Lichenologica* 96: 157–174.

Kondratyuk, S.Y., Kärnefelt, I., Elix J.A. & Thell, A. (2009a). New *Caloplaca* species from Australia. *Bibliotheca Lichenologica* 99: 259–278.

Kondratyuk, S.Y., Kärnefelt, I, Elix, J.A. & Thell, A. (2009b). Contributions to the Teloschistaceae, with particular reference to the Southern Hemisphere. *Bibliotheca Lichenologica* 100: 207–282.

Kondratyuk, S.Y., Kärnefelt, I.,Thell, A. & Elix, J.A. (2010). Six new species of *Caloplaca* (Teloschistaceae, Ascomycota) from Australasia. *Australasian Lichenology* 66: 30–43.

Kondratyuk, S.Y., Elix, J.A., Kärnefelt, I. & Thell, A. (2011). Four New *Caloplaca* species with depsidones. *Bibliotheca Lichenologica* 106: 179–186.

Kondratyuk, S.Y., Elix, J.A., Kärnefelt, I. & Thell, A. (2012). An artificial key to Australian *Caloplaca* species (Teloschistaceae, Ascomycota). *Bibliotheca Lichenologica* 108: 141–160.

Kondratyuk, S.Y., Elix, J.A., Kärnefelt, I. & Thell, A. (2013a). Five new *Caloplaca* species (Teloschistaceae, Ascomycota) from Australia. *Folia Cryptogamica Estonica* 50: 41–48.

Kondratyuk, S.Y., Jeong, M.-H., Yu, N.-H., Kärnefelt, I., Thell, A., Elix, J.A., Kim, J., Kondratiuk, A.S. & Hur, J.-S. (2013b). Four new genera of teloschistoid lichens (Teloschistaceae, Ascomycota) based on molecular phylogeny. *Acta Botanica Hungarica* 55: 251–274.

Kondratyuk, S.Y., Jeong, M.-H., Yu, N.-H., Kärnefelt, I., Thell, A., Elix, J.A., Kim, J., Kondratiuk, A.S. & Hur, J.-S. (2014a). A revised taxonomy for the subfamily Caloplacoideae (Teloschistaceae, Ascomycota) based on molecular phylogeny. *Acta Botanica Hungarica* 56: 93–123.

Kondratyuk, S.Y., Kärnefelt, I., Thell, A., Elix, J.A., Kim, J., Jeong, M.-H., Yu, N.-H., Kondratiuk, A.S. & Hur, J.-S. (2014b). A revised taxonomy for the subfamily Xanthorioideae (Teloschistaceae, Ascomycota) based on molecular phylogeny. *Acta Botanica Hungarica* 56: 141–178.

Kondratyuk, S.Y., Kärnefelt, I., Thell, A., Elix, J.A., Kim, J., Kondratiuk, A.S. & Hur, J.-S. (2015). Brownlielloideae, a new subfamily in the Teloschistaceae (Lecanoromycetes, Ascomycota). *Acta Botanica Hungarica* 57: 321–343.

Lumbsch, H.T., Ahti, T., Altermann, S., et al. [100 others] (2011). One hundred new species of lichenized fungi: a signature of undiscovered global diversity. *Phytotaxa* 18: 1–137.

McCarthy, P.M. (2016). *Checklist of the Lichens of Australia and its Island Territories.* (Australian Biological Resources Study: Canberra). http://www.anbg.gov.au/abrs/lichenlist/introduction.html [Version 22 January 2016].

Santesson, R. (1944). Contributions to the lichen flora of South America. *Arkiv för Botanik* 31A(7): 1–28.

Søchting, U. & Lutzoni, F. (2003). Molecular phylogenetic study at the generic boundary between the lichen-forming fungi *Caloplaca* and *Xanthoria* (Ascomycota, Teloschistaceae). *Mycological Research* 107: 1266–1276.

Søchting, U. & Øvstedal, D.O. (1992). Contributions to the *Caloplaca* flora of the western Antarctic region. *Nordic Journal of Botany* 12: 121–134.

*Journal of the Adelaide Botanic Gardens* 29 (2016) 71–145


# Revision of *Kunzea* (Myrtaceae). 2. Subgenera *Angasomyrtus* and *Salisia* (section *Salisia*) from Western Australia and subgenera *Kunzea* and *Niviferae* (sections *Platyphyllae* and *Pallidiflorae*) from eastern Australia

*H.R. Toelken*

State Herbarium of South Australia, G.P.O. Box 1047, Adelaide, South Australia 5001
*E-mail*: hellmut.toelken@sa.gov.au

## Abstract

This contribution to a revision of the Australian species of *Kunzea* is, similarly to previous publications on western Australian groups, primarily based on the gross morphology examined on herbarium specimens and field observations. The species are, however, arranged in infrageneric groupings supported by molecular research. Descriptions and brief discussions of four subgenera and six sections are included throughout in order to provide an overall classification of the genus, although not all species are described in full detail.

Keys, descriptions and illustrations to the following 23 accepted species are provided (new taxa in bold): *K. ambigua* (Sm.) Druce, ***K. aristulata***, ***K. axillaris***, ***K. badjaensis***, *K. bracteolata* Maiden & Betche, ***K. caduca***, *K. calida* F.Muell., *K. cambagei* Maiden & Betche, *K. capitata* (Sm.) Rchb. ex Heynh. subsp. *capitata*, subsp. ***seminuda***, ***K. dactylota***, *K. flavescens* C.T.White & Francis, *K. graniticola* Byrnes, ***K. juniperoides*** subsp. ***juniperoides***, subsp. ***pernervosa***, *K. muelleri* Benth., *K. obovata* Byrnes, ***K. occidentalis***, *K. opposita* F.Muell. var. *opposita*, var. *leichhardtii* Byrnes, *K. parvifolia* Schauer, ***K. petrophila***, *K. pomifera* F.Muell., *K. rupestris* Blakeley, ***K. sericothrix***, ***K. truncata***.

Natural putative hybrids between taxa occurring in close proximity have been examined and evaluated. No experimental artificial hybridization was performed, but as many hybrids as possible were examined in population studies. Hybrids are briefly described from cited specimens, and are reported under the first name in the hybrid formula.

**Keywords**: Myrtaceae, *Kunzea*, taxonomic revision, new species, nomenclature, Australia.

## Introduction

When Smith (1797) described *Leptospermum ambiguum* and *Metrosideros capitata* and later added *M. ericifolia* Sm. (1813), all now species of *Kunzea*, this foreshadowed the difficulties experienced in the delineation of the genus *Kunzea* from the beginning to the present. De Candolle (1828) placed these three species into a separate grouping of *Metrosideros*, all with alternate leaves, but he also replaced the first name (*L. ambiguum*) with *M. corifolia* Vent. Reichenbach (1828) introduced in the same year the genus *Kunzea*. Although he did not validly publish the genus, the name was at the time widely accepted, in contrast to *Tillospermum* by Salisbury (1814), which was completely overlooked and never used in the literature, because it was published in an obscure publication. Toelken (1981a) eventually conserved *Kunzea* Reichb. with the type species *K. capitata* (Sm.) Heynh. over the earlier unused homonym *Kunzia* Spreng. (1818) and later (Toelken 1981b) over the even earlier name *Tillospermum*.

Several additional generic names were published and used, such as *Pentagonaster* by Klotzsch (1836), *Stenospermum* by Heynhold (1841) and *Salisia* by Lindley (1839), for some species with extreme morphology, like *K. baxteri* (Klotzsch) Schauer, *K. ambigua* (Sm.) Druce and *K. pulchella* (Lindl.) A.S.George, respectively. Other species, now included in *Kunzea*, were previously included in or transferred to other genera, such as *Agonis* (DC.) Sweet, *Baeckea* L., *Callistemon* R.Br., *Melaleuca* L. and *Metrosideros* Gaertner (cf. citations under genus). The distinguishing features for *Kunzea* changed and although the original characteristic, the capitate stigmas (cf. Flowers) repeatedly resurfaced, no single character could be found to distinguish the genus.

However, Bentham (1867) following Schauer (1844) established a wider concept, which is similar to the one presented here. He even included *K. peduncularis* F.Muell. (1855) (the oldest name for the *K. ericoides* complex in the genus *Kunzea* in preference to the earlier *Baeckea phylicoides* A.Cunn. ex Schauer, 1843, following the so-called "Kew Rule"; Nicolson 1991) into the genus, a concept which lasted for a long time. But eventually, this was challenged by Cheel (1943), Blake (1958) and Byrnes (1982), who preferred to place the latter species complex in *Leptospermum phylicoides* (A.Cunn. ex Schauer) Cheel, the oldest Australian name.

Thompson (1983) argued on the basis of the size and curved nature of the stamens and thin-walled anthers that this species complex should be placed in *Kunzea*, namely in *K. ericoides* (A.Rich.) Joy Thomps., the oldest name within the complex, which Richard (1832) published originally for a New Zealand plant. The publication of the hybrid *Kunzea sinclairii* × *Leptospermum scoparium* (Harris et al. 1992) swung arguments again for the inclusion of the *K. ericoides* complex in *Leptospermum* Forster & G. Forster, at least in New Zealand (Petterson 2006).

Molecular research on the systematics of the *Leptospermum* suballiance by O'Brien et al. (2000) supported Thompson's concept. They also confirmed that *Kunzea* belongs into the monophyletic *Leptospermum* suballiance within the *Leptospermum* alliance of Myrtaceae, as originally proposed by Briggs and Johnson (1979) and developed in Johnson & Briggs (1983, 1984). O'Brien et al. (2000) also included the recently published *Angasomyrtus salina* (Trudgen & Keighery 1983) in *Kunzea*.

De Lange et al. (2010) provided further detailed molecular studies, specifically on the genus *Kunzea*, adopted the same delineation of the genus as Thompson (1983) and proposed an infrageneric classification, which divides the genus into four subgenera (Tab. 1). Similar to the genus, the subgenera are also not easily defined morphologically:

(1) Subgen. *Kunzea* included species with mainly pink-flowered globular inflorescences in eastern Australia.

(2) The Western Australian species, except *K. salina*, were combined into subgen. *Salisia* (Lindl.) Toelken & de Lange, which is subdivided into three sections: sect. *Salisia* (Lindl.) Benth. included large red-flowered *K. baxteri* and *K. pulchella*; while sect. *Floridae* (Toelken) Toelken & de Lange includes the floriferous pink-flowered species, but with few-flowered inflorescences and often with petals longer than stamens; and sect. *Zeanuk* Toelken (1996) retains the species with pink or yellow flowers in multi-flowered inflorescences, but now includes only Toelken's subsect. *Arborescentes* and *Globosae*.

(3) *Kunzea salina*, being without obvious affinities to other species, remains the only species in subgen. *Angasomyrtus* (Trudgen & Keighery) de Lange & Toelken.

(4) The eastern subgen. *Niviferae* Toelken & de Lange consists of usually white-flowered species with often elongate inflorescences. It is divided into three sections: sect. *Platyphyllae* Toelken & de Lange with irregular branching (cf. Branches) and globular inflorescences from mainly Queensland, but also one species from the Northern Territory; species of sect. *Niviferae* have unequally long stamens, some of which are shorter than the petals, truncate flower buds and they not only occur in south-eastern Australia but are also widespread in New Zealand; sect. *Pallidiflorae* Toelken & de Lange, which shares regular branching from each leaf axil with sect. *Niviferae*, but is distinguished by all stamens being equally long, as well as acute flower buds, and occurs in New South Wales, eastern Victoria and Tasmania.

Detailed discussions under each of these infrageneric taxa demonstrate the variation recorded.

The species concepts, in contrast, provided fewer problems in evaluation. The fact that a number of changes and new species were published by Toelken (1996) and that more are described here must largely be attributed to more detailed exploration and discerning collecting, particularly since the 1960s.

Field studies soon, however, revealed another challenge to the identification of taxa in the form of natural putative hybrids (cf. Hybridization) between adjoining species. Hybridization is generally attributed to interference with vegetation through cultivation and urbanization, and hybrids are therefore often found, for instance, along road works, as this would have disturbed vegetation locally. However, some variation recorded on older herbarium specimens could now with field observations and more material available also be interpreted as putative hybrids. Although most putative hybrids in *Kunzea* are limited to a few plants in the majority of species populations, each one may persist for many years, as they are perennials like their putative parents. This is of particular importance in the mainly tree-like *K. ericoides* complex (Toelken, in prep.), in which a number of species produce extensive local hybrid swarms leading to a reduction of the species complex to a single species by some authors (Bentham 1867, Cheel 1943, Thompson 1983). De Lange (2014) adopts a different approach and increased the number of species from two to ten in New Zealand.

Furthermore, recognition of infraspecific taxa is obscured by extensive hybridization between, for instance, *K. capitata* subsp. *capitata* and subsp. *seminuda* (cf. Hybridization). In the case of the rare *K. juniperoides* subsp. *pernervosa* the taxon cannot be clearly delineated as in one locality extensive hybridization with *K. parvifolia* has caused all the flowers to be pink, while in other localities they are predominantly white and the occasional occurrences of pink-flowered plants might either have to be attributed to wider introgressional effects or natural variation, as it has been found in *K. badjaensis*. Too little material is available at present to make a critical judgement (cf. Typification of *K. juniperoides* subsp. *pernervosa*). An awareness of the problems concerning hybrids will hopefully create more discerning field work to fill in details or simply add to the known range of variation of hybrids and taxa.

Hybrids are also frequently mentioned in gardening publications as many of the species and hybrids of *Kunzea* are by now widely used in horticulture. Elliot & Jones (1993) in their comprehensive *Encyclopaedia of Australian Plants* have extensively described growing conditions, etc.

**Characters**

*Habitats*. The majority of species of *Kunzea* grow in temperate areas particularly in south-western and eastern Australia, but in Queensland their distribution also extends into the subtropics and tropics. The occurrence of *K. petrophila* in the dry tropical environment along the Keep River in the western parts of the Northern Territory is unusual. Also, *K. pulchella* and *K. baxteri* grow in semi-arid areas of temperate Western Australia. At the other extreme, *K. muelleri* also extends the distribution of the genus into subalpine localities of New South Wales and Victoria.

While all these species grow on acid soils, *K. pomifera* prefers alkaline substrates and is usually found on sandy soils along the coasts of Victoria and South Australia. The unique *K. salina* is also found on sand dunes, but occurs only around semi-arid salt lakes north of Esperance in Western Australia.

*Habit*. Most species of *Kunzea* are shrubs, but a number of the taller shrubs, especially in sect. *Niviferae*, can develop in competition in forests into trees up to 10 m tall; in New Zealand, de Lange (2014) reports trees up to 30 m for *K. robusta*. In a small area, particularly on forest margins, one can find a range of multi-stemmed shrubs to single-stemmed trees of the same species, e.g. *K. flavescens*. Habit is not a very reliable character to distinguish species in *Kunzea*, but it is important to be aware of its variability. At the other extreme, some species, such as *K. cambagei* and *K. pomifera*, have a prostrate to decumbent habit. *Kunzea badjaensis* also usually has a decumbent habit, which is particularly low in the horticultural form registered as 'Badja Carpet', but specimens of the species have also been recorded to grow to shrubs up to 1m tall.

Although occasionally recorded, little is known about suckering in many species, such as *K. pomifera* or *K. micrantha*, and a subsequent production of lignotubers has been recorded for *K. micrantha* subsp. *petiolata* (G. Cockerton, pers. comm.). Suckering is, for instance, thought to be important for maintaining the population of the rare *K. rupestris*. This phenomenon is also common in species of the *K. ericoides* complex, where some species even produce repeated lignotubers on often extensive underground rhizomes from which they will sucker (de Lange et al. 2010, p. 316). Such plants will freely regenerate when the aerial parts have been removed for road works.

*Branches*. The type of branching of kunzeas is not reflected in their variable habit from mainly shrubs to trees or prostrate perennials. For instance, species of the subgenera *Salisia* and *Kunzea*, as well as sect. *Platyphyllae* of subgen. *Niviferae* (except *K. petrophila*), will in every season's growth develop a few lateral branches, usually at the base of a growth flush and subsequent nodes will remain unbranched.

This irregular branching contrasts with that of species of subgen. *Angasomyrtus*, as well as sections *Pallidiflorae* and *Niviferae* of subgen. *Niviferae*, which develop branches in the axils of all leaves at each node, although many of them (mainly the distal ones) remain short shoots, usually shorter than the subtending leaf, at least in the first year. During the next season some of these short shoots, but not all of them, will grow out into long branches and the overall branching of these species ultimately resembles that of kunzeas with irregular branching growth flushes.

While the decurrent leaf bases of most species of the first group with irregular branching are rounded and scarcely noticeable on the internodes, they have sharp-edged margins of more or less distinct flanges with grooves on either side, concurrent with the regular branching in the subgenera *Angasomyrtus* and *Niviferae*, as above.

Characteristic of the Western Australian species of the sections *Floridae* and *Zeanuk* is the slough-like shedding of large sheets of mainly the epidermis of developing branches. The upper layers split into usually long slivers on branches of the similarly pink-flowered eastern species of subgen. *Kunzea* as well as on most of the mainly white-flowered species of the subgenera *Angasomyrtus* and *Niviferae*. The subsequent development of bark of young branches (up to 8 mm in diameter) are described, because it, in contrast to that of the main stems, can be examined on herbarium specimens for identifications. Bark of older stems, useful as it might be, is only rarely represented on herbarium material, and is much less distinctive.

*Leaves*. In most species of *Kunzea* the leaves are spirally arranged (usually 3/5). De Candolle (1828) already drew attention to the alternate leaves of the three original species then placed into *Metrosideros*. However, *K. opposita* and *K. calida* with short internodes are exceptions and have opposite leaves; in *K. muelleri* the leaves are very close to one another, so that at times they too appear opposite.

A characteristic of leaves of many species of Kunzea are their "pinched" apices, which only appear to be acuminate to cuspidate, because their distal leaf margins are more or less strongly incurved.

The number of main veins of a leaf varies in different species and can be an important characteristic of some species, while in others, e.g. *K. capitata* subsp. *capitata*, it can be very variable.

*Inflorescence*. The usually densely clustered, apparently spike-like inflorescences of *Kunzea* are complex inflorescences described by Briggs & Johnson (1979) as a blastotelic conflorescence, or more specifically for the genus a **botryum**. This inflorescence consists of few to many part-inflorescences reduced to a single unit, usually with sessile flowers, each in the axil of a bract and subtended by two bracteoles (= pherophylls and prophylls, respectively, in Briggs & Johnson 1979). Much use is made here of the characteristic shape, size and indumentum of these bracts and bracteoles to dis-

tinguish taxa, but it must also be stressed that these characteristics may vary from the lower flowers to the distal ones on the same inflorescence, as demonstrated in many of the illustrations. The inflorescence develops directly from a resting bud covered with scales or **perules**, which differ in shape and often grade into that of the lower bracts, but these intermediates are rarely observed, because at least the upper perules are usually shed early (caducous). Occasionally one also finds rudimentary flowers in the axil of what seems to be a perule, while other perules next to them are without floral buds, so that the distinction based on size, shape or the functionality between bracts and the sterile perules cannot be used as a critical difference between the two, as observed in, for instance *K. juniperoides*. As the usually larger intermediates are commonly shed early, although usually not in *K. juniperoides*, the "retained perules" as observed on herbarium specimens, are used in descriptions. Bracts with or without a flower in their axil subtend the flower head or individual flowers.

Every inflorescence ends in a latent terminal vegetative bud or rarely also in a few leaves in species of the subgen. *Angasomyrtus* and sect. *Niviferae*. After flowering or once the fruit are shed, growth will commonly continue from the terminal bud, and only rarely from nodes below the inflorescence, as for instance, in species of sect. *Floridae* (Toelken 1996). The inflorescence is therefore usually distal, or is usually only "apparently terminal" on branches at least while flowering, as used in the descriptions to avoid confusion for the observer.

Commonly, kunzeas have dense, more or less globular inflorescences, but there are variations to this basic pattern in different groups. The majority of species belonging to subgen. *Kunzea* and sections *Floridae*, *Zeanuk*, *Platyphyllae* and *Pallidiflorae* have more or less globular inflorescences with usually scale-like chartaceous deciduous bracts and bracteoles, but in the last two sections there is a tendency for the bracts to become membranous or leaf-like, often with a green central strip. These bracts are usually dropping early (caducous: Jackson 1965), i.e. before or at flowering, while deciduous bracts of the former group are shed at the same time as the deciduous fruit. The leaf-like bracts are often associated with more elongate inflorescences with separated flowers, as distinct from dense usually globular ones, which have under exceptional environmental circumstances become more elongate mainly in sect. *Zeanuk* in Western Australia (Toelken 1996).

Elongate inflorescences with usually caducous bracts and bracteoles are, however, the norm for *K. pulchella* and *K. baxteri* from Western Australia. These two species with large, mainly red ornithophilous flowers are placed in a separate sect. *Salisia*. This seemingly unexpected placement is juxtaposed to the pink or yellow entomophilous flowers on globular inflorescences of sections *Floridae* and *Zeanuk,* representing different pollination syndromes within the subgen. *Salisia*. Even within sect. *Salisia* inflorescences differ: while the inflorescences of *K. pulchella* are loosely racemiform with flowers more or less stalked, those of *K. baxteri* are of the bottle-brush type with sessile flowers and a terminal tuft of leaves resembling (mimicking?) closely those of species of *Callistemon.* In fact, Lindley (1839) and Mueller (1863) had mistakenly placed specimens of these species into *Callistemon*, but both species have flowers with stamens in more than one whorl, which are longer than the petals, as well as deciduous fruit typical of the genus *Kunzea*, in spite of their unusually large red flowers. *K. baxteri,* unusually for the genus, has the occasional proliferation of up to three inflorescences in succession, each with some vegetative growth in between, within a good season on cultivated plants.

The loose inflorescences with stalked flowers and often some terminal leaves of the small white-flowered species of the *K. ericoides* complex (*K.* sect. *Niviferae*; de Lange 2014) usually have membranous and caducous bracts and bracteoles, at least on the basal flowers or short axillary inflorescences. However, on the longer inflorescences, which are distal on main branches, the distal bracts are fleshy and leaf-like and are often retained after flowering similar to those in *K. pulchella*. These longer inflorescences also normally end in a few leaves and, under favourable conditions, the terminal bud at the end of a few leaves restarts growth early before fruit have matured. The inflorescence of species of sect. *Niviferae*, with flowers with long and short stamens presenting anthers at different levels and relatively short styles, suggest a different pollination syndrome. This is also indicated by the absence of hybrids with species of other groups, even though they often occur in close proximity, particularly as they hybridise in profusion within their own group. A similar comparison cannot, however, be made in the case of *K. baxteri* and *K. pulchella*, as they occur in semi-arid areas where no other species of *Kunzea* grow. Experimental hybridization has not been pursued in this study and hybrids from horticulture are not recorded here.

The inflorescences of *K. salina* in subgen. *Angasomyrtus* are also similar to those of the *K. ericoides* complex, although the inflorescence is usually reduced to few apparently axillary flowers. The elongated inflorescences on one specimen (*L.A.Craven et al. 9098*) are very similar to those of species of sect. *Niviferae*, except that the flowers are sessile or almost so.

Some elongate inflorescences are even more complex, as they consist of more or less globular inflorescences born in terminal position as well as on short axillary branches from distal nodes of last year's growth unit and, although they are usually separate units, species with small inflorescences, such as, *K. muelleri* and *K. dactylota*, often produce distally on branches larger conglomerates of conflorescences or superconflorescences (Briggs & Johnson 1979). Similar larger units have also been recorded for some species of sect. *Niviferae*.

*Flowers*. The flowers of *Kunzea* species are distinguished from those of *Leptospermum* by the stamens being arranged in more than one row and filaments, which are curved down into the free hypanthium in the buds (Thompson 1983). Once the stamens are expanded they are also usually longer than the petals even in the very much larger ornithophilous flowers of *K. pulchella* and *K. baxteri*. The exceptions are species of sect. *Floridae* (Toelken 1996), where the petals are relatively large in comparison to the stamens; and in subgen. *Angasomyrtus* and section *Niviferae*, both with unequally long sets of stamens, some of which are also shorter than the petals. In both of the latter groups the styles are also usually shorter than the stamens.

Flower colour, i.e. the colour of the petals and usually filaments, is generally species specific, except for the occasional plant with white flowers, as recorded for both the ornithophilous, usually red-flowered forms, e.g. *K. pulchella* var. *albiflora* (S.Moore) Grieve, and the entomophilous commonly pink-flowered *K. parvifolia* var. *alba* Maiden & Betche. Such infraspecific taxa are not adopted here, because in these cases flower colour could not be linked to other distinguishing characters. The exception is the white-flowered form of *K. muelleri*, which is here raised to species level as *K. dactylota*, as it showed additional characteristics, a different habitat and distribution.

*Gynoecium*. In early diagnoses of *Kunzea*, the capitate stigma was considered the essential character to distinguish it from *Leptospermum* (Smith 1797, Reichenbach 1828, Heynhold 1840), and it is commonly observed in subgenera *Kunzea* and *Salisia*, but even there, the stigma is often flat to funnel-shaped, as is more typical of the subgenera *Angasomyrtus* and *Niviferae*. However, the variation of the shape of the stigma is not even characteristic of different groups, but may be individual to species as, for instance, the obliquely truncate stigma of *K. newbeyi* (Toelken 1996, fig. 8G). In most species the styles are about as long as the filaments, so that the stigma is at about the level of the anthers. Distinctly shorter styles are found in *K. salina* and species of sect. *Niviferae*, which also have long and shorter stamens.

The number of locules of the ovary rarely varies much and is usually characteristic of a species, while the number of ovules per locule often varies greatly with environmental conditions, particularly in species with many ovules. However, a reduction in the number of locules from 5 or 4 in the majority of species of the Western Australian subgenus *Salisia* and eastern section *Niviferae* to commonly 3 in the majority of eastern *Kunzea* species, but also the western *K. salina*, is often continued in certain species of different infrageneric groupings to 2 locules. Most of the species with only 2 locules have also a reduced number of ovules per locule, e.g. *K. eriocalyx* and *K. cambagei*, and these ovules are elongate and pendulous, while ovules are usually short and spreading in other species of the genus. The lower number of ovules per locule, as used by Bentham (1867) to distinguish the mainly Western Australian pink-flowered species of his sect. *Eukunzea*, as opposed to sect. *Salisia*, which has numerous ovules, can, with so much more material at hand, no longer be accepted as a natural grouping.

The placentation also varies from commonly axile to apical in species with reduced numbers of ovules per locule. The style base is more or less sunk into the apex of the ovary. This is in turn surrounded by the often hairy hypanthium, which continues into the erect free hypanthium surmounted by the calyx lobes. The upper surface of the ovary is usually glabrous and only in a few species, such as forms of *K. obovata* and *K. parvifolia*, densely hairy or with few bristles next to the style in *K. cambagei*.

*Fruit*. Normally the fruits of *Kunzea* are dry capsules, which dehisce by loculicidal slits on the upper surface of the ovary similar to those of *Leptospermum*, but in contrast to most species of that genus and the similar *Callistemon* the fruit are deciduous. However, exceptions are the non-dehiscent, but dry fruit of *K. cambagei* and fleshy and dark purple to black ones of *K. pomifera*.

**Hybrids**

Few of the treatments of *Kunzea* in recent floras mention or allow for natural putative hybrids, while Elliot & Jones (1993) frequently refer to hybridization in horticulture, where, admittedly, different species are often brought in close contact. Although in this paper, hybrids might appear to be reported out of proportions to their relative infrequent occurrence indicated, this is intentional in order to draw attention to possible problems in delineation or identification of taxa (cf. Toelken 1996, p. 30), particularly as they are less common in eastern than in western Australian species. Less is also known about the range of variation of individual hybrid combinations of eastern Australian species, so that they are not included in the keys to species, as was done for the western Australian ones (Toelken 1996).

Often, having examined a few hybrids in the field, similar unusual plants or specimens are quickly recognised, once the variation of the species in the area has been established. Population studies are essential in the recognition of hybrids. They are usually found where two or more species occur in close proximity, but, as there are usually only a few hybrids in an area, they might not display the complete range of variation between the putative parents.

In order to confirm hybridity of specimens (cf. Toelken 1996) pollen was stained for several hours in cotton blue in lactophenol. Hybrids are indicated by a high percentage, frequently higher than 10% of otherwise normal looking pollen grains remaining unstained or not stained very well (cf. de Lange & Murray 2004, de Lange et al. 2005). In extreme cases the pollen may show a varying number of pollen grains of an irregular shape. In some cases, as in hybrids of, for instance, *K. juniperoides* subsp. *pernervosa* × *K. parvifolia*, more

**Table 1.** Classification of *Kunzea*, listing all Australian taxa. References to detailled descriptioned of species and subspecies not discussed in this paper are given (JABG = J. Adelaide Bot. Gard.). The revision of *Kunzea* sect. *Niviferae* is currently in preparation and will be published separately.

**A. *Kunzea* subgen. *Salisia*** (Lindl.) Toelken & de Lange

**A.1. *Kunzea* sect. *Salisia*** (Lindl.) Benth.
1. *K. pulchella* (Lindl.) A.S.George
2. *K. baxteri* (Klotzsch) Schauer

**A.2. *Kunzea* sect. *Floridae*** (Toelken) Toelken & de Lange
3. *K. similis* Toelken — JABG 17: 86
   3a. subsp. *similis* — Nuytsia 17: 390
   3b. subsp. *mediterranea* Toelken & G.F.Craig — Nuytsia 17: 390
4. *K. acuminata* Toelken — JABG 17: 88
5. *K. pauciflora* Schauer — JABG 17: 90
6. *K. preissiana* Schauer — JABG 17: 92
7. *K. acicularis* Toelken & G.F.Craig — Nuytsia 17: 392
8. *K. jucunda* Diels — JABG 17: 95
9. *K. affinis* S.Moore — JABG 17: 98
10. *K. strigosa* Toelken & G.F.Craig — Nuytsia 17: 394
11. *K. cincinnata* Toelken — JABG 17: 101
12. *K. eriocalyx* F.Muell. — JABG 17: 103

**A.3. *Kunzea* sect. *Zeanuk*** Toelken
13. *K. montana* (Diels) Domin — JABG 17: 34
14. *K. sulphurea* Tovey & P.Morris — JABG 17: 37
15. *K. glabrescens* Toelken — JABG 17: 41
16. *K. ericifolia* (Sm.) Rchb. ex Heynh. — JABG 17: 44
   16a. subsp. *ericifolia* — JABG 17: 44
   16b. subsp. *subulata* Toelken — JABG 17: 47
17. *K. spathulata* Toelken — JABG 17: 48
18. *K. clavata* Toelken — JABG 17: 50
19. *K. recurva* Schauer — JABG 17: 55
20. *K. newbeyi* Toelken — JABG 17: 60
21. *K. rostrata* Toelken — JABG 17: 62
22. *K. ciliata* Toelken — JABG 17: 64
23. *K. praestans* Schauer — JABG 17: 66
24. *K. micrantha* Schauer — JABG 17: 69
   24a. subsp. *micrantha* — JABG 17: 72
   24b. subsp. *petiolata* Toelken — JABG 17: 73
   24c. subsp. *oligandra* (Turcz.) Toelken — JABG 17: 75
   24d. subsp. *hirtiflora* Toelken — JABG 17: 77
25. *K. micromera* Schauer — JABG 17: 78

**B. *Kunzea* subgen. *Kunzea***
26. *K. juniperoides* Toelken
   26a. subsp. *juniperoides*
   26b. subsp. *pernervosa* Toelken
27. *K. dactylota* Toelken
28. *K. muelleri* Benth.
29. *K. pomifera* F.Muell.
30. *K. aristulata* Toelken
31. *K. rupestris* Blakeley
32. *K. cambagei* Maiden & E.Betche
33. *K. capitata* (Sm.) Rchb. ex Heynh.
   33a. subsp. *capitata*
   33b. subsp. *seminuda* Toelken
34. *K. obovata* N.Byrnes
35. *K. parvifolia* Schauer
36. *K. badjaensis* Toelken
37. *K. opposita* F.Muell.
   37a. var. *opposita*
   37b. var. *leichhardtii* N.Byrnes
38. *K. calida* F.Muell.

**C. *Kunzea* subgen. *Angasomyrtus***
(Trudgen & Keighery) de Lange & Toelken
39. *K. salina* (Trudgen & Keighery) de Lange & Toelken

**D. *Kunzea* subgen. *Niviferae*** Toelken & de Lange

**D.1. *Kunzea* sect. *Platyphyllae*** Toelken & de Lange
40. *K. flavescens* C.T.White & Francis
41. *K. bracteolata* Maiden & E.Betche
42. *K. graniticola* N.Byrnes
43. *K. sericothrix* Toelken
44. *K. caduca* Toelken
45. *K. truncata* Toelken
46. *K. petrophila* Toelken

**D2. *Kunzea* sect. *Pallidiflorae*** Toelken & de Lange
47. *K. occidentalis* Toelken
48. *K. ambigua* (Sm.) Druce
49. *K. axillaris* Toelken

**D3. *Kunzea* sect. *Niviferae*** Toelken & de Lange
— To be published separately.

than 50% of the pollen failed to stain properly for some specimens. As this is a reflection of the degree of compatibility of the parent species concerned, this can only be observed in some putative hybrids; in others the staining is marginal. In spite of shortcomings of the less objective method of studying abnormal morphological characters in order to establish hybrids rather than local variation, this is in most cases the only guide short of molecular examinations to draw attention to putative hybrids (cf. Toelken 1996, pp. 30, 31).

A full recombination of the characteristics of the putative parents is only found in rare localised hybrid swarms, e.g. *K. recurva* × *K. sulphurea* (Toelken 1996, p. 59) or *K. capitata* subsp. *capitata* × *K. capitata* subsp. *seminuda* along the lower Shoalhaven River. Only among species of sect. *Niviferae* (Toelken, in prep.) extensive hybrid swarms (de Lange et al. 2005, 2014) have considerably impeded recognition of species and lead to the one-species concept in this species complex referred to under different names (cf. Introduction) like *K. peduncularis* in Bentham (1867), *K. phylicoides* in Cheel (1943), Blake (1958), Byrnes (1982), or *K. ericoides* in Thompson (1983). De Lange et al. (2005), however, established ten species in New Zealand alone by identifying hybrids through performing a wide range of interspecific and intergeneric (with *Leptospermum scoparium*) artificial cross combinations, examining their intermediate morphology and, in complex molecular studies including *genomic in situ hybridization* (GISH), determined compatibilities and relations. The authors report that members of the New Zealand species of the *K. ericoides* complex hybridise easily, but artificial crosses failed between them and the almost indistinguishable Australian members of the complex; nor were hybrids obtained between them and Australian species of other subgenera, e.g. *K. baxteri* (subgen. *Salisia*) and *K. parvifolia* (subgen. *Kunzea*).

De Lange & Murray (2004) found that the chromosome numbers for most of the species examined are 2n = 22. Few crosses of *Kunzea* species with *Leptospermum scoparium* produced viable seedlings but no flowers, presumably because some hybrids had 2n

= 23. The lack of hybrids between Australian species of the *K. ericoides* complex (subgen. *Niviferae* sect. *Niviferae*) and, for instance, the somewhat similar *K. ambigua* (subgen. *Niviferae* sect. *Pallidiflora*), which often grow close to one another, have usually been assumed to be due to the very much shorter style and two rows of stamens with anthers in a different position in the *K. ericoides* complex. Similarly, it seems the very different arrangement of floral parts (presume different pollination syndrome) in the flowers of the ornithophilous species, *K. baxteri* and *K. pulchella*, have prevented hybridization with other kunzeas rather than their remote habitats, as no such hybrids are mentioned in horticulture (Elliot & Jones 1993) where they are often grown close to one another. However, examinations of incompatibility of Australian taxa could be beneficial to a better understanding of relationships, in view of a recent record of a group of plants of *K. parvifolia* (subgen. *Kunzea*) × *K. peduncularis* (sect. *Niviferae*) (Molyneux & Forrester 2016, p. 53).

In spite of this definite indication of hybridity the actual identification of the putative parents remains subjective, as it usually relies largely on a knowledge of parent species potentially present at a locality. Usually it involves only two parents and no multiple-species hybrids were encountered although compatibility does not seem to exclude this possibility. It is possible to get confused by the apparently different morphology of hybrids involving the same parent taxa, if only a few have been recorded between the only two taxa at a specific locality, because each hybrid collection represents only a small part of the range of recombination of characters of the parent species. An example of this is an interim presentation, e.g. *K. cambagei* × *K. parvifolia A* and *B*, where the two hybrids could not be included in the same description as no more plants could be found even though the area was searched.

In view of the incompletely known variation of hybrids, they are presented as a hybrid formula (not nothospecies) together with a brief diagnosis and specimens examined, including related material of the putative parents, are always cited at the end of the species first in alphabetical order within the hybrid formula. A cross reference is, however, included under the second taxon in the formula. New records are encouraged in the hope of obtaining a better understanding and a wider circumscription of the potential variation of hybrids. The variation presented by one hundred year-old specimens of the subspecies of *K. capitata*, such as *A.A.Hamilton NSW123986* (Wentworth Falls) and *A.A.Hamilton NSW123987* (Lawson) can now be interpreted, branch by branch, as taxa as well as hybrids. They might also indicate that the subspecies in those days had a different distribution than at present. Natural hybrids are apparently not only due to human intervention in native vegetation, as was already recorded by J. Drummond in the 1840s for *K. montana* × *K. recurva* in Western Australia (cf. Toelken 1996, p.31).

For general identification purposes it is necessary to remember that:

(1) only in rare extensive hybrid swarms, such as, *K. capitata* subsp. *capitata* × *K. capitata* subsp. *seminuda*, or among members of the *K. ericoides* complex, the variation might present a complete range of intermediates between the parent taxa;

(2) in places with only a few hybrid plants present, they need not closely resemble one another as shown in the situation of, for instance, *K. cambagei* × *K. parvifolia* A and B;

(3) a change in flower colour can be indicative of hybridity, but has often also been recorded for variants of otherwise homogenous populations of species, as, for instance, *K. parviflora* var. *alba*;

(4) perennial hybrid plants of kunzeas can at least theoretically outlast one or both putative parents at a locality, as is probably the case in *K. cambagei* × *K. capitata* subsp. *seminuda*, since only the first parent was recorded from the immediate vicinity;

(5) hybrids will be much more common in cultivated plants (Elliot & Jones 1993), because, in gardens, species might be brought together, which in their natural habitat would not be able to come into contact with one another.

## Taxonomy

This revisional study is based predominantly on herbarium material supported by field studies. Wherever possible hybrids were examined in situ, but once the variation of taxa had been established, others were detected among existing herbarium material and then often confirmed by additional material collected. The infrageneric classification is based on a collaborative effort between molecular evidence by de Lange's team and morphological reasoning further discussed under each of these taxa. This recently published infrageneric classification of *Kunzea* (de Lange et al. 2010) provides a basis to attempt to unite the already published parts of the revision with the present one by describing and discussing each infrageneric taxon in order to provide a better overview of the whole genus.

Although most types known were examined, a few isotypes and/or syntypes of synonyms could not be located and/or not examined in detail and are thus indicated as n.v. (non vide). Lectotypes were selected for many names in accordance with Article 9.2 (McNeill et al. 2012), but it was often difficult to discern proper duplicates (isolectotypes), especially for species described by F. Mueller, as specimens from the same locality usually did not bear the same detailed inscriptions which qualified them to be selected as the lectotype. Such specimens are indicated as "possible isolectotypes", as this may enable the identification of others, because many more duplicates than examined by the author were often distributed by F. Mueller to herbaria world-wide.

***Kunzea* Rchb.**

Consp. Regn. Veg. 175 (1828), nom. cons.: Toelken, Taxon 30: 350 (1981) & Toelken, Taxon 30: 828 (1981); Schauer in Lehm., Pl. Preiss. 123 (1844); Benth., Fl. Austral. 3: 111 (1867); Byrnes, Austrobaileya 1: 468–471 (1982); Joy Thomps., Telopea 2: 379–383 (1983); de Lange et al., Austral. Syst. Bot. 23: 316 (2010). — **Type species:** *Kunzea capitata* (Sm.) Heynh., lecto. cons.: Toelken, Taxon 30: 350 (1981).

*Tillospermum* Salisb., Monthly Rev. 75: 74 (1814). — **Type species:** *Leptospermum ambiguum* Sm.

*Pentagonaster* Klotzsch, Allg. Gartenzeitung 4: 112 (1836). — **Type species:** *Pentagonaster baxteri* Klotzsch.

*Stenospermum* Sweet, Hort. Brit. ed. 2, 209 (1830), Sweet, Hort. Brit. ed. 3, 220 (1839), nom. inval., sine descr. generico. — *Stenospermum* Sweet ex Heynh., Nomencl. Bot. Hort. 1: 787 (1841), nom. illeg., *Kunzea* in syn. — **Type species:** *Stenospermum capitatum* Sweet ex Heynh. (lecto., designated here; cf. Typification).

*Salisia* Lindl., Sketch Veg. Swan R. x (1839). — **Type species:** *Salisia pulchella* Lindl.

*Angasomyrtus* Trudgen & Keighery, Nuytsia 4(3): 435 (1983). — **Type species:** *Angasomyrtus salina* Trudgen & Keighery.

*Leptospermum* auctt. non Forster & G.Foster: Sm., Trans. Linn. Soc. London 3: 264 (1797), pro parte, quoad *L. ambiguum* Sm.; Cheel, J. & Proc. Roy. Soc. New South Wales 76: 230 (1943), pro parte, quoad *L. phylicoides* (A.Cunn. ex Schauer) Cheel; S.T.Blake, Proc. Roy. Soc. Queensland 69: 77 (1958), pro parte, quoad *L. phylicoides* (A.Cunn. ex Schauer) Cheel; Byrnes, Austrobaileya 1(5): 468 (1984), pro parte, quoad *L. phylicoides* (A.Cunn. ex Schauer) Cheel.

*Metrosideros* auctt. non Gaertner: Sm., Trans. Linn. Soc. London 3: 273 (1797), pro parte, quoad *M. capitata* Sm.; Vent., Jard. Malmaison 1: 46 (1804), pro parte, quoad *M. corifolia* Vent.; Sm. in Rees, Cycl. 23: *Metrosideros* no. 16 (1813), pro parte, quoad *M. capitata* Sm., *M. ericifolia* Sm.; Hoffmanns., Verz. Pfl.-Kult. 80 (1824), pro parte, quoad *M. abietina* Hoffmanns.; Spreng., Syst. Veg., ed. 16, 2: 490, 491(1825), pro parte, quoad *M. capitata* Sm., *M. corifolia* Vent., *M. ericifolia* Sm.; DC., Prodr. 3: 225 (1828), pro parte, quoad *M. capitata* Sm., *M. corifolia* Vent., *M. ericifolia* Sm.

*Callistemon* auctt. non R.Br.: Rchb., Iconogr. Bot. Exot. I: 59, t.84 (1827), pro parte, quoad *C. capitatus* (Sm.) Rchb.; Lindl., Edward's Bot. Reg. 24, pl. 7 (1838), pro parte, quoad *C. macrostachyum* Lindl.; F.Muell., Fragm. 3: 153 (1863), pro parte, quoad *C. haenesii* F.Muell.

*Melaleuca* auctt. non L: Sieber, *Fl. Mixta 609* (1836), pro parte, quoad *M. thymoides* Sieber nom. nud., nom. illeg., non Labill. (1806); Spreng., Syst. Veg., ed. 16, 3: 336 (1825), pro parte, quoad *M. eriocephala* Sieber ex Spreng.

*Baeckea* auct. non L.: Schauer, Repert. Bot. Syst. 2, Suppl. 1: 921 (1843), pro parte, quoad *B. phylicoides* A.Cunn. ex Schauer.

Shrubs or trees; branches with leaf bases often becoming flanged with incurved margins. *Leaves* alternate, rarely opposite. *Inflorescences* usually apparently terminal botrya, globose to elongate, with usually sessile, rarely stalked flowers; bracts deciduous and scale-like chartaceous, rarely fleshy and ± leaf-like and then often caducous, with 1–9 main veins from the base; bracteoles in pairs, deciduous to caducous. *Flowers* 5-merous, pink to purple or white, rarely yellow or red; free hypanthium surmounting ovary. *Calyx lobes* persistent on fruit. *Petals* free and usually clawed. *Stamens* usually more than 20, in more than one series, usually longer than petals or if shorter then often some incurved. *Ovary* (2) 3 to 5-locular; placenta peltate with axile placentation and numerous spreading ovules, rarely apical with few pendulous ovules. *Fruit* usually a loculicidal capsule with apical splits, rarely indehiscent or fleshy and berry-like in *K. pomifera*, deciduous.

*Discussion*. Throughout the wide distribution of the genus in Australia and New Zealand one finds, not surprisingly, a number of extreme forms amongst the over 60 species recognised at present. While the majority of species have pink to purple, rarely white or yellow, sessile flowers densely clustered into globular inflorescences, there are also two species with large red ornithophilous flowers on elongate inflorescences, and more than 12 species, generally referred to as the *K. ericoides* group, with loosely arranged stalked flowers with unequally long stamens and usually distal leaves on racemiform inflorescences.

*Typification & nomenclature*. Concurrent with presenting a proposal (Toelken 1981a) for the conservation of *Kunzea* Rchb. (1828) against the disused homonym *Kunzia* Spreng. (1818) together with the conserved lectotype *K. capitata* (Sm.) Heynh., Mabberley (1980) drew attention to the even earlier name for the genus, *Tillospermum* Salisb. (1814). Toelken (1981b) proposed a second conservation of *Kunzea* against *Tillospermum*, which is earlier so that it automatically conserves the genus over *Kunzia* (conservation confirmed in *Taxon* 33: 299, 1984).

Although Sweet (1830, 1839) published the combination *Stenospermum capitatum*, it was invalid, because the genus name had not previously been validly published (Article 35.1, McNeill et al. 2012). The reference by Heynhold (1840) to *Kunzea* Rchb. validated the genus and species names quoted (Article 38.1, McNeill et al. 2012), but, as he cited *Kunzea* in the synonomy, *Stenospermum* becomes an illegitimate name (Article 52.1, McNeill et al. 2012). As Heynhold did not designate a type species for the genus, *Stenospermum capitatum* Sweet ex Heynh. is here selected as the type, in agreement with discussions in *Kunzea* that the capitate stigma was regarded at the time as the main distinguishing character of the genus (Reichenbach 1828, Mabberley 1980, Toelken 1981a). However, Reichenbach (1828) did not make the combinations for the four species cited under *Kunzea*.

A few species now included in the genus *Kunzea* were described in *Metrosideros* and de Candolle (1828) included them in a separate group with alternate leaves. Others were retained in the genus *Leptospermum*, and in particular species of *Kunzea* [subgen. *Niviferae*] sect. *Niviferae* were only recently placed by Thompson (1983) into *Kunzea*.

**Key to infrageneric taxa**

**1.** Inflorescence with 2 (–6) flowers and ending in a tuft of leaves . . . . . **C. *Kunzea* subgen. *Angasomyrtus***
**1:** Inflorescence with 6–∞ flowers or without terminal tuft of leaves
**2.** Western Australian plants; ovary mainly with 4 or 5 locules; epidermis of young branches shed in large slough-like pieces, or flowers red and filaments 10–24 mm long . . . . . **A. *Kunzea* subgen. *Salisia***
**3.** Filaments 10–24 mm long; hypanthium > 3.3 mm long; petals red, rarely white . . . . . **A.1. *K.* sect. *Salisia***
**3:** Filaments 2–5.5 mm long; hypanthium < 3.1 mm long; petals pink to off-white
**4.** Inflorescence with (1–) 3–8 (–12) flowers; stamens usually shorter than, or as long as petals . . . **A.2. *K.* sect. *Floridae***
**4:** Inflorescence with > 10 flowers; stamens longer than petals . . . . . **A.3. *K.* sect. *Zeanuk***
**2:** Eastern Australian plants; ovary with 2 or 3, rarely 5 locules; epidermis of young branches shed in strips
**5.** Petals pink, rarely yellow or white; inflorescence globular or rarely elongate; not branching at each node . . . . . **B. *Kunzea* subgen. *Kunzea***
**5:** Petals white; inflorescence frequently elongate; often regularly branching at each node (except irregularly branching in most species of sect. *Platyphylla*) . . . . . **D. *Kunzea* subgen. *Niviferae***
**6.** Distal young main branches irregularly branching from some nodes and these lateral branches are usually longer than the subtending leaf (except *K. petrophila*, but then with acuminate bracts); bracts usually scale-like chartaceous . . . . . **D.1. *K.* sect. *Platyphylla***
**6:** Distal main branches developing lateral branches in the axil of each leaf, but some remain short shoots which are shorter or as long as subtending leaf; bracts fleshy and green and often with membranous margin
**7.** Mature flower buds apically acute with erect calyx lobes; inflorescence usually without terminal leaves . . . . . **D.2. *K.* sect. *Pallidiflorae***
**7:** Mature flower buds apically truncate with incurved calyx lobes; inflorescence with few to many terminal leaves . . . . . **D.3. *K.* sect. *Niviferae***

## A. *Kunzea* subgen. *Salisia* (Lindl.) Toelken & de Lange

in de Lange et al., Austral. Syst. Bot. 23: 317 (2010). — *Salisia* Lindl., Sketch Veg. Swan R. x (1839). — *Kunzea* sect. *Salisia* (Lindl.) Benth., Fl. Austral. 3: 115 (1867), pro parte, quoad *K. baxteri*, *K. pulchella*. — **Type species:** *Salisia pulchella* Lindl.

Main branches with irregular growth flushes (or woody regular short shoots in *K. pulchella*); branches with raised but scarcely decurrent leaf bases not flanged, with epidermis splitting into large slough-like membranes (or if not then flowers red in sect. *Salisia*). *Leaves* with pinched apex, with 1 main vein, except 3 in *K. baxteri*. *Inflorescence* usually a globular botryum with 1–40 flowers, without terminal leaves (or elongate and with red flowers and terminal leaves in *K. baxteri* and *K. pulchella*), with growth after fruiting usually continuing terminally (or often laterally in sect. *Floridae*); *bracts* broad and scale-like chartaceous, persistent to ± deciduous (or leaf-like, caducous with red flowers for *K. baxteri* and *K. pulchella*); *bracteoles* scale-like chartaceous, persistent or deciduous (or leaf-like, caducous with red flowers for *K. baxteri* and *K. pulchella*). *Flowers* sessile (or stalked with usually large red flowers in *K. pulchella*), with bulging and rounded to acute apex of flower buds. *Stamens* usually longer than petals (except about equally long in species of sect. *Floridae*), erect-spreading. *Ovary* with (2–) 4 or 5 locules, each with peltate placenta with 10–∞ short spreading ovules (or 1 to few elongate and pendulous); *style* slender and as long as stamens, often much longer than the free hypanthium.

*Discussion*. As the description indicates, subgen. *Salisia* is a morphologically very diverse group, mainly due to some extremes, such as *K. baxteri* and *K. pulchella* in sect. *Salisia*, while species of the sections *Zeanuk* and *Floridae* form more homogeneous groups. The small-flowered kunzeas in Western Australia of the latter two sections, were segregated by Toelken (1996, in a slightly different arrangement) from similar-flowered species in eastern Australian mainly by the slough-like abscission of the epidermis on developing branches. In subgen. *Salisia*, the two large-flowered species unique to the genus, were added based on molecular evidence (de Lange et al. 2010), so that this subgenus includes all Western Australian species except for *K. salina*. The latter species is referred to the separate subgen. *Angasomyrtus*, which shows closer affinities to the eastern Australian subgenera *Kunzea* and *Niviferae*, as discussed there.

Clade A (combined rDNA ITS and ETS) in de Lange et al. (2010, fig. 1) shows strong support (BS = 91%) for separation from the eastern species and even stronger separation (BS =100%) of sect. *Zeanuk* from sect. *Salisia* and sect. *Floridae*. Sect. *Salisia*, including *K. baxteri* and *K. pulchella*, has always been regarded morphologically as quite distinct on account of the large, usually red ornithophilous flowers, but the two species differ so obviously by their individual inflorescences, bracts and venation of the leaves. O'Brien et al. (2000) already mentioned that the two species showed greater affinity to *K. montana* (sect. *Zeanuk*) than to the eastern Australian species. However, the terminal branches on Clade A1 (sect. *Salisia* in de Lange et al. 2010, fig. 1) of *K. pulchella*, and particularly of *K. baxteri* are remarkably long to indicate much evolutionary development in contrast to the very short branch lengths of species of the sections *Floridae* and *Zeanuk*.

While species of sect. *Zeanuk* are found mainly west of Albany, species of sections *Floridae* and *Salisia* occur in the south-eastern parts of Western Australia,

east of Ravensthorpe, and *K. pulchella* further inland to the north-east.

## A.1. *Kunzea* sect. *Salisia* (Lindl.) Benth.

Fl. Austral. 3: 112, 115 (1867), pro parte, quoad *K. sericea* (synonym of *K. pulchella*), *K. baxteri*. — *Salisia* Lindl., Sketch Veg. Swan R. x (1839). — **Type species:** *Salisia pulchella* Lindl.

*Pentagonaster* Klotzsch in Otto & A.Dietr., Allg. Gartenzeitung 4: 113 (1836). — *Kunzea* sect. *Pentagonaster* (Klotzsch) Kuntze in Post & Kuntze, Lex. Gen. Phan. 311 (1903), nom. illeg.: sect. *Salisia* (Lindl.) Benth. is cited in synonomy. — **Type species:** *Kunzea baxteri* (Klotzsch) Schauer.

Shrubs or trees 1.5–3 (–5) m tall, branching in seasonal growth flushes in *K. baxteri* and ± regular branching in *K. pulchella*; young branches shedding epidermis in fibrous strips. *Leaves* with 1 (–3) main veins. *Inflorescence* with (1–) 6–25 (–40) flowers, ± elongate spiciform to racemiform, usually single, apparently terminal, rarely proliferating in *K. baxteri*, or subtended by smaller globular ones on lateral short shoots in *K. pulchella*. *Flowers* sessile or stalked, red, sometimes white; *stamens* 3–5 times longer than petals; *ovary* (4–) 5-locular; ovules 40–65 per locule, spreading.

*Discussion*. The two species with very diverging morphology do not present at first sight a very homogenous grouping, and yet, they were always placed together, presumably because of their large ornthophilous flowers, unique to the genus.

Both species are usually associated with granite outcrops. *K. pulchella* occurs in the semi-arid areas of in the central south-west, while *K. baxteri* is found in south-eastern Western Australia.

### Key to species of sect. *Salisia*

**1.** Leaves obovate, with 1 central vein, with lateral margins ± incurved; flowers with stalk (1–) 2.5–5.5 mm long; seed testa with many short vertical cells ..... **1. *K. pulchella***

**1:** Leaves linear, linear elliptic, usually with three main veins, ± flat; flowers sessile or subsessile with stalk less than 1 mm long; seed testa with few long vertical cells ..... **2. *K. baxteri***

### 1. *Kunzea pulchella* (Lindl.) A.S.George

W. Austral. Naturalist 10: 32 (1966); Erickson et al., Fl. & Pl. W. Austral. 132, fig. 410 (1973); Blackall & Grieve, How to know W. Austral. Wildfl. ed. 2, 3A: 101, pl. 7 (1980); J.Green, Census Vasc. Pl. W. Austral. ed. 2, 128 (1985); C.A.Gardner, Wildfl. W. Austral. ed. 16, 97 (1986); Beard, Plantlife W. Austral. 125 (1990); Corrick & Fuhrer, Wildfl. S. W. Austral. 131 (1996). — *Salisia pulchella* Lindl., Sketch Veg. Swan R. x (1839). — **Type:** Swan River, *J.Mangles s.n.* (holo.: CGE).

*Kunzea sericea* Turcz., Bull. Soc. Imp. Natural. Moscou 20, 1: 162 (1847), non *Leptospermum sericeum* Labill.; Benth., Fl. Austral. 3: 117 (1867); Blackall & Grieve, How to know W. Austral. Wildfl. 1: 293 (1954); C.A. Gardner, Wildfl. W. Austral. 107, fig. (1959); Beard, W. Austral. Pl. 77 (1965); Morcombe, Austral. Wildfl. 102, fig. (1970). — *Kunzea sericea* var. *sericea*. S.Moore, J. Linn. Soc. Bot. 34: 192 (1899). — **Type:** Swan River, *J.Drummond 3rd coll. 40* (holo.: KW, n.v.; PERTH, photo!; possible iso.: BM, CGE, K, MEL92408, W).

*Kunzea sericea* var. *albiflora* S.Moore, J. Linn. Soc. Bot. 34: 192 (1899). — *Kunzea pulchella* var. *albiflora* (S. Moore) Grieve in Blackall & Grieve, How to know W. Austral. Wildfl. ed. 2, 3A: 101 (1980), nom. inval., sine basionym. — **Type:** Gnarlbine, *S.Moore s.n.*, ix.1895 (holo.: BM; iso.: K).

*Kunzea sericea* var. *glabra* C.A.Gardner, J. Roy. Soc. W. Austral. 9, 1: 35 (1923). — **Type:** Mt Marshall near Bencubbin, *C.A.Gardner FDH 1714* (holo.: PERTH); *C.A.Gardner 1214* (iso.: PERTH; see Typification).

Shrubs 1.5–3 (–4) m tall, spreading, often sparsely branched; *young branches* with leaf bases barely raised and no flanges visible on long shoots, pubescent to tomentose with short ± appressed hairs overtopped by fewer longer ones; *early bark* splitting longitudinally and fluted, becoming somewhat corky with uppermost layer ± irregularly peeling. *Leaves* alternate; *petiole* (0–) 0.4–0.8 (–1.8) mm long, usually ± spreading; *lamina* obovate to oblanceolate, (3.2–) 5–14 (–20) × (2.1–) 2.5–5.2 (–8.2) mm, acute to cuspidate, rarely obtuse with or without mucro, gradually tapering into indistinct petiole, flat on both surfaces but adaxially somewhat folded lengthwise and canaliculate at least distally, with one major vein but rarely visible, usually densely appressed-pubescent, rarely glabrescent. *Inflorescence* a loose elongate, rarely rounded botryum with (1–) 6–14 (–18) flowers, each on a stalk (1–) 2.5–4.5 (–5.6) mm long, terminal on main and on short lateral shoots, often, but not always, with terminal vegetative growth continuing while flowering; *perules* usually 3–5, oblong-oblanceolate to obovate, with 1 vein, leaf-like, appressed-hairy, usually caducous; *bracts* ovate to obovate, 4.5–6 (–8) × 3.1–4 mm, acute to rounded, leaf-like, with 1 main vein, appressed-hairy or with hairs only along the central ridge of both sides, ciliate, caducous; *bracteoles* in pairs, ovate to linear-lanceolate, 4.4–5 × 2.4–2.7 (–3) mm, acute to acuminate, with one central vein, ± appressed-hairy or along the central ridge, ± ciliate, caducous. *Hypanthium* (3.3–) 4–5 (–5.2) mm when flowering (free tube 2.2–3.1 mm), outside usually densely pubescent to hirsute with ± spreading long and short hairs up to the base of filaments. *Calyx lobes* triangular, (1.6–) 2.4–3.2 (–3.4), acute to acuminate as margins become ± incurved, without membranous margins, densely covered with appressed to spreading hairs on the inside and outside. *Corolla lobes* almost orbicular, sessile or almost so, (3.2–) 3.8–5 (–5.6) mm, deep red or sometimes white, often with few to many cilia along the erose margins. *Stamens* usually more than 70 in more than one row; *filaments* 10–17 mm long (3–4 times longer than corolla lobes); *anthers* broadly ellipsoidal, 0.6–0.75 mm long, each with large terminal centrifugal gland bulging on both sides of connective. *Ovary* (4) 5 locules, with style base not or scarcely sunk into the upper surface; *placenta* a broadly elliptic to orbicular stiffly fleshy disc with short attachment in the centre, with ± connate lobes each with 4 rows of

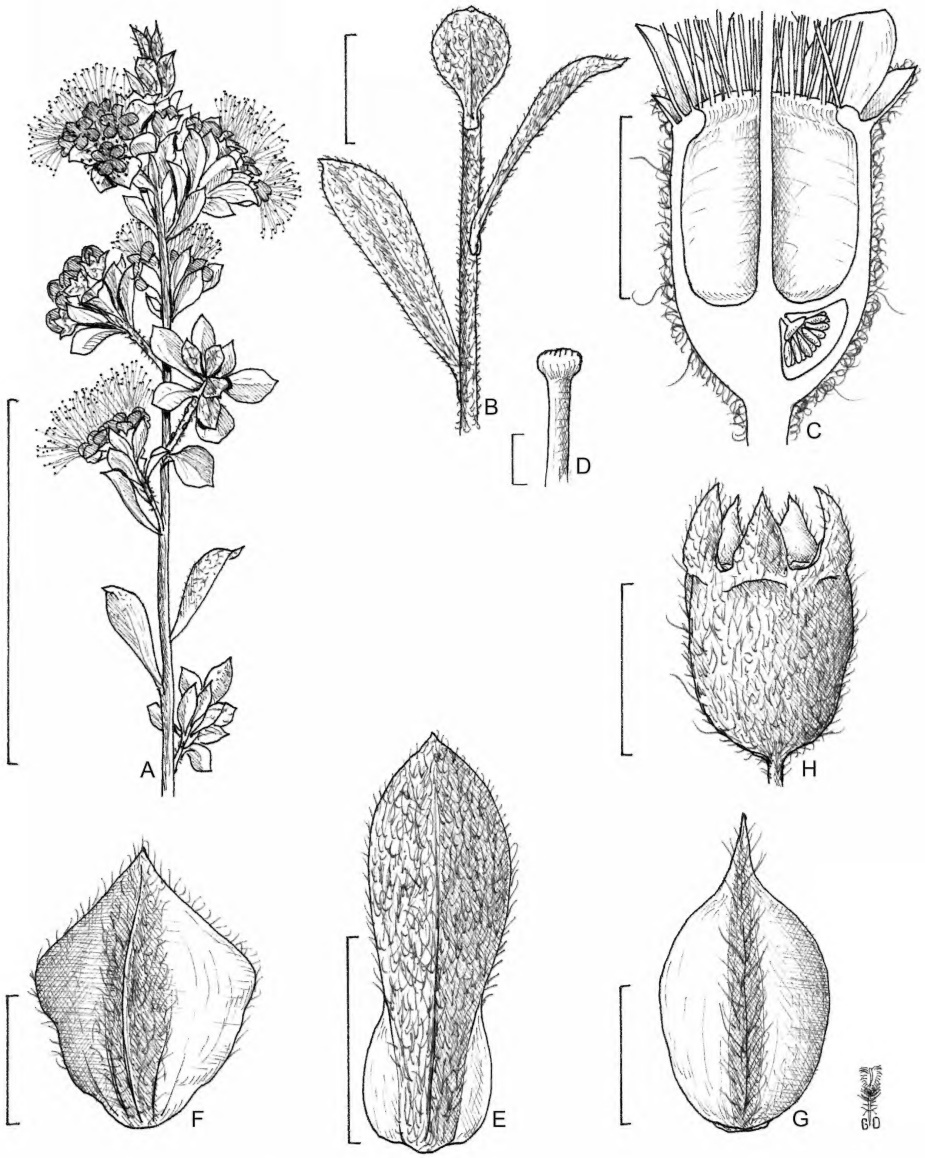


**Fig 1.** ***Kunzea pulchella***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** capitate stigma; **E** perule; **F** bract; **G** bracteole; **H** fruit. — Scale bars: **A** 4 cm; **B**, **C** 2 mm; **D** 0.5 mm; **E** 5 mm; **F** 3 mm; **G** 2.5 mm; **H** 4 mm. — **A–G** *M.Crisp 5601* (CANB); **H** *A.M.Ashby 3619* (AD).

ovules; *ovules* 44–51 per locule, subequal, spreading to somewhat pendulous; *style* 13.8–16.4 mm long, scarcely broadened basally; *stigma* slightly broader than style, with central depression. *Fruit* a usually broadly urceolate capsule, (3.6–) 4–4.8 (–5.2) mm, with stiffly erect calyx lobes. *Seeds* scarcely angular, obconical but with distal broad side ± oblique, 1–1.3 mm long, covered with several short (c. 2–3 times longer as broad) cells in vertical lines becoming faintly ribbed. *Flowers*: (September) October, November (rarely to March). *Common name*: **Silky kunzea** (Blackall & Grieve 1954, Morcombe 1970); **granite kunzea** (Erickson et al. 1973, Blackall & Grieve 1980, Corrick & Fuhrer 1996). **Fig. 1.**

*Distribution and ecology*. Growing in sandy to sandy-clay soils usually over granite outcrops in open scrubland in Avon, Roe and Coolgardie districts of Western Australia.

*Conservation status. Kunzea pulchella* is locally common; it is not threatened (W.A. Herbarium 1998–).

*Diagnostic features.* The large usually red, sometimes white, ornithophilous flowers superficially resemble those of *K. baxteri*, but *K. pulchella* is distinguished by its obovate to oblanceolate leaves, loosely branching inflorescence with more or less stalked flowers so that the central axis is usually visible, broadly triangular calyx lobes which are shorter than the corolla, flat (not stiffly conical) apex of mature buds, and shorter filaments. Even the occasional white-flowered plants are distinct, because all parts of their flowers are bigger than in any other species of *Kunzea*.

*Variation*. The indumentum of the whole plant, but particularly of the hypanthium of this species varies from usually short-sericeous to almost glabrous, but also to tomentose or even villous on some inflorescences. Some young plants examined, as well as coppicing branches had almost glabrous leaves except for the leaf margins.

The flower colour is recorded as red or white without a range of intermediates (e.g. *P.H.Barrett 11* – white; *12* – red), but varieties based on this difference could not be accepted, because this character could not be linked to supporting characters and/or ecological or geographical differences. On a specimen with white flowers, *B.J.Lepschi 3850*, the observation "brown honeyeaters and spiny cheeked honeyeaters are feeding on the flowers" indicates that red flower colour is not a prerequisite for birds frequenting them.

Similarly, plants from the south-west of the species' distribution area with usually marginal cilia on the often erose corolla lobes were not given taxonomic rank because they show a large range of variation in respect of these characteristic petals, and this character could not be linked with supporting characters.

*Notes*. The distinctive camptodromus veining of the leaves of this species, the rather lax inflorescence with flowers on stalks with bracteoles above their middle, and unusually short cells on the seed testa are different from the usually elongate cells of other species in the genus. This species is also unique in the genus *Kunzea* because its style is already elongated considerably in as yet unopened buds so that it often becomes curved sideways or even downwards when the flowers open.

*Typification*. Turczaninow (1847) clearly stated that the type of ***K. sericea*** was number 40 collected on J. Drummond's fourth expedition, which Bentham (1867) already queried, as the collector had not been to the area concerned then and points out that specimens of this species from his first and third collection trip were both numbered 40. In view of this uncertainty of whether details on the holotype specimen were wrongly transcribed, all specimens of *J.Drummond 40* examined were enumerated as possible isotypes.

Turczaninow did not refer to or intend *K. sericea* to be a new combination for *Leptospermum sericeum* Labill. (cf. Thompson 1983, p. 361) and the photograph of the holotype in PERTH leaves no doubt about them being two different species. The two species of different genera were often confused in literature, because of their similar indumentum on the leaves. Gardner (1964) clearly distinguishes the inland species, *K. sericea*, from the coastal *L. sericeum*, which "is the common plant of the islands of the Recherche Archipelago".

The number of the type quoted in the protologue of Gardner's ***K. sericea* var. *glabra*** is No 1714 of the Forestry Department Herbarium, while his personal collector's number is 1214 (Wilson 1988). Therefore the former is cited as holotype and the latter as isotype, although they have different numbers.

*Selection of specimens examined (c. 100 seen)*

Western Australia: *A.M.Ashby 3619*, Mt Churchman, 7.ix.1970 (AD, W); *E.T.Bailey 349*, Wadderin Rocks, ix.1947 (PERTH); *P.H.Barrett 11 & 12*, 5 mls [8 km] SW Woolgangie, xi.1952 (PERTH – white & red flowers); *M.D.Crisp 6335,* Dingo Rock, 31.x1979 (CANB); *P.de Rebeira 39*, NE Muckinbudin near Yadegin Hill, 16.x.1978 (PERTH); *A.Eaton MEL92788*, Youndegin, 1891 (MEL); *D.B.Foreman 1093*, Bandicoot Rd, Tutanning Wildlife Sanctuary, 19.xi.1995 (MEL); *F.Fraser NSW124253*, between Kununoppin & Mt Marshall, 1919 (NSW – white & red flowers); *C.A.Gardner & W.E.Blackall 948*, 85 mls [136 km] E Southern Cross, 11.x.1931 (PERTH); *C.A.Gardner s.n.*, Bullabulling, 13.ix.1934 (PERTH – white & red flowers); *R.Helms s.n.*, c. 32 km W Red Kangaroo Hill, 13.xi.1891 (AD, NSW, MEL); *D.L.Jones 7959 et al.*, Hospital Rock, W Menzies on Riverina Rd, 26.ix.1991 (CANB); *T.R.Lally & B.J.Lepschi 424*, Dingo Rock, 17.x.1994 (CANB); *F.Lullfitz 1739*, E Pingelly, 29.xi.1962 (PERTH); *B.J.Lepschi 3850*, Yellowdine Rock, near Yellowdine Roadhouse, 1.xii.1997 (CANB – only white flowers); *S.Moore s.n.*, between Southern Cross & Siberia, i.1895 (BM); *R.W.Purdie 6104*, Baladjie Rock Nature Res., 24.ix.2005 (CANB); *S.B.Rosier 164*, Mollerin Rock, x/xi.1959 (PERTH); *L.W.Sage 2000*, Ive Rock, 7 km SW Mt Finnerty, Jaundi Stn, 6.x.1999 (CANB); *E.M.Scrymgeour 2120*, c. 8 mls [12.8 km] N Paynes Find, 20.ix.1967 (PERTH); *P.J.Spencer 16*, Keokanie Rock, on Bodallin North Rd, 13.vi.1995 (CANB); *F.H.Vachell 2*, Kellerberrin, 1903 (K); *J.Z.Weber 5200*, Mt Churchman, 19.x.1975 (AD, PERTH); *L.C.Webster NSW147255*, Coolgardie, 1899 (NSW); *J.H. Willis MEL92684*, Wongan Hills, 17.x.1963 (MEL).

*Putative hybrids*

**(i) *K. baxteri* × *K. pulchella*:** see (2) *K. baxteri*.

### 2. *Kunzea baxteri* (Klotsch) Schauer

in Lehm., Pl. Preiss. 1: 123 (1844); Benth., Fl. Austral. 3: 117 (1867); Blackall & Grieve, How to know W. Austral. Wildfl. 1: 294 (1954); Beard, W. Austral. Pl. 77 (1965); Erickson et al., Fl. & Pl. W. Austral. 135, fig. 425 (1973); Blackall & Grieve, How to know W. Austral. Wildfl., ed. 2, 3A: 101, pl. 7 (1980); C.A.Gardner, Wildfl. W. Austral., ed. 16, 97 (1986); N.G.Walsh & Stajsic, Census Vasc. Pl. Victoria, ed. 8, 108 (2007). — *Pentagonaster baxteri* Klotzsch in Otto & A.Dietr., Allg. Gartenzeitung 4: 115 (1836). — **Type:** King George Sound, W. Baxter (neo., designated here: K000843010).

*Callistemon macrostachyum* Lindl., Edward's Bot. Reg. 24, pl. 7 (1839). — **Type:** lecto., designated here: plate 7 (1838).

*Callistemon hainesii* F.Muell., Fragm. 3: 153 (1863). — **Type citation:** "In tractu steriliore litorali inter promontoria Cape Arid et Cape Le Grand. Maxw." — **Type:** lecto., designated here: MEL 92502; possible isolecto.: PERTH; possible syn.: MEL 92500; MEL 92503, MEL 92504; cf. Typification below.

Shrubs 3 (–5) m tall, spreading, moderately to densely branched; young branches with leaf bases scarcely raised and with indistinct flanges, pubescent to tomentose with ± appressed hairs overtopped by scattered longer ones; *early bark* splitting longitudinally and fluted becoming corky with upper layers often irregularly flaking. *Leaves* alternate; *petiole* (0.9–) 1.1–1.7 mm long, appressed or upper third spreading; *lamina* oblong to oblong-elliptic, (6–) 14–18 (–24) × (1.2–) 2.5–3.5 (–5) mm, obtuse to almost rounded, rarely acute, usually abruptly tapering into petiole and apex, flat above and below or with margins slightly recurved, with 3 veins from the base, sparsely to densely hairy, rarely glabrescent on both surfaces, with dense hairs in more than one row along the margin. *Inflorescence* an elongate botryum with 16–27 (–39) flowers, terminal on all branches and often continued in terminal vegetative growth while flowering; *perules* rarely more than 5, linear-lanceolate to ovate, with 1–5 (–7) veins, leaf-like, glabrous except for marginal cilia, caducous; *bracts* at base oblong to linear-lanceolate becoming broadly obovate distally, (4.5–) 5–9 × (1.2–) 2–3 (–5) mm, acute to acuminate distally, leaf-like, with (1–) 3–5 veins, pubescent outside, mainly caducous but some distal ones often persisting for some time; *bracteoles* not seen. *Hypanthium* (6.5–) 7.8–8.8 mm long when flowering (free tube 3–3.5 mm long), outside with short appressed hairs and occasionally overtopped by spreading longer hairs, inside glabrous or with few scattered hairs. *Calyx lobes* linear-triangular, 4.5–6 mm long, drawn into stiffly erect point, without membranous margins, covered with short appressed hairs outside and inside. *Corolla lobes* obovate-orbicular, shortly clawed, (3.5–) 3.8–4.7 (–5.4) mm long, deep red, with very fine hairs on claw and surrounding areas. *Stamens* (30–) 41–52, in more than one row; filaments 19–24 mm long (4–5 times longer than corolla lobes); *anther* ellipsoidal, 0.9–1.2 mm long, with subterminal gland centrifugally attached to connective. *Ovary* (4) 5-locular, with style base deeply sunk into the upper surface; placenta a broadly elliptic to orbicular, stiffly fleshy disc, with short cylindrical attachment in the middle, with connate lobes each with 4 rows of ovules; ovules 43–63 per locule, subequal but marginal ones often distinctly smaller, spreading; style 19.6–25.4 mm long, slender and scarcely broadened towards the base but often with few hairs; stigmas scarcely broader than style, with central depression. *Fruit* a cup- to urn-shaped capsule 8–9.6 mm long, with stiffly erect calyx lobes. *Seeds* ± angular obconical to obpyramidal, 1.8–2.2 mm long, often with irregular appendix, covered with faint vertical ridges (10–12 per side) rarely with slightly oblique connections. *Flowers*: August–October (November, March, June). *Common name*: **Baxter's kunzea** (Erikson et al. 1973, Blackall & Grieve 1980). **Fig. 2.**

*Distribution and ecology*. Growing in coarse sandy soil or laterite, often associated with granite or rarely in quartzite outcrops in dry scrub, heath vegetation or eucalyptus woodland in eastern Eyre and Roe districts of the South Western Province and sporadically naturalised near Melbourne, Victoria.

*Conservation status*. Not threatened (W.A. Herbarium 1998–); 3KC in Briggs & Leigh (1996).

*Diagnostic features*. Next to *K. pulchella, K. baxteri* is the only species in the genus with large red ornithophilous flowers, but they are born on a spiciform inflorescence resembling those typical of *Callistemon*. They are, however, distinguished from the latter genus by the persistent calyx lobes and deciduous fruit. The oblong leaves and sessile flowers on a stout floral axes and slender erect calyx lobes easily distinguish *K. baxteri* from *K. pulchella.*

*Variation*. For *K. baxteri* a wide range in the density of the indumentum has been recorded, particularly in respect of the leaves. As a result some whole plants may appear grey-leaved next to others with deep green leaves, as some collectors have commented.

Vegetative growth above the inflorescence usually continues at and/or after flowering, and cultivated plants have been observed to produce up to three successive inflorescences within one extended season.

*Typification*. Klotzsch's herbarium was destroyed in B (Stafleu & Cowan 1986) and no specimen of ***Pentagonaster baxteri*** annotated by the author could be located. He stated in the protologue that he maintained the specific epithet as used in English horticulture ("Calothamnus Baxteri H. Angl."), in honour of William Baxter, who had introduced the species to Europe from seeds he collected in Australia in the 1820s. It seems therefore appropriate to select a well preserved specimen attributed to W. Baxter at K as neotype, although this specimen had not been seen by Klotzsch.

As no specimen seems to have been preserved of ***Callistemon macrostachyum*** the illustration part of the protologue is selected as lectotype.

F. Mueller never wrote the name ***Callistemon hainesii*** on any specimens he consulted, so that it is difficult to assign a type to that species, because there are several possible specimens collected by G. Maxwell in his herbarium. The locality of none of the specimens specifically agrees with that provided in the protologue, but "shrubby plants 3 to 4 ft" in the description is found on MEL 92502. This specimen is chosen as lectotype. The hairs on a leaf and other fragments on a sheet in PERTH indicate that these could have been taken from the lectotype. The other specimens at MEL could also

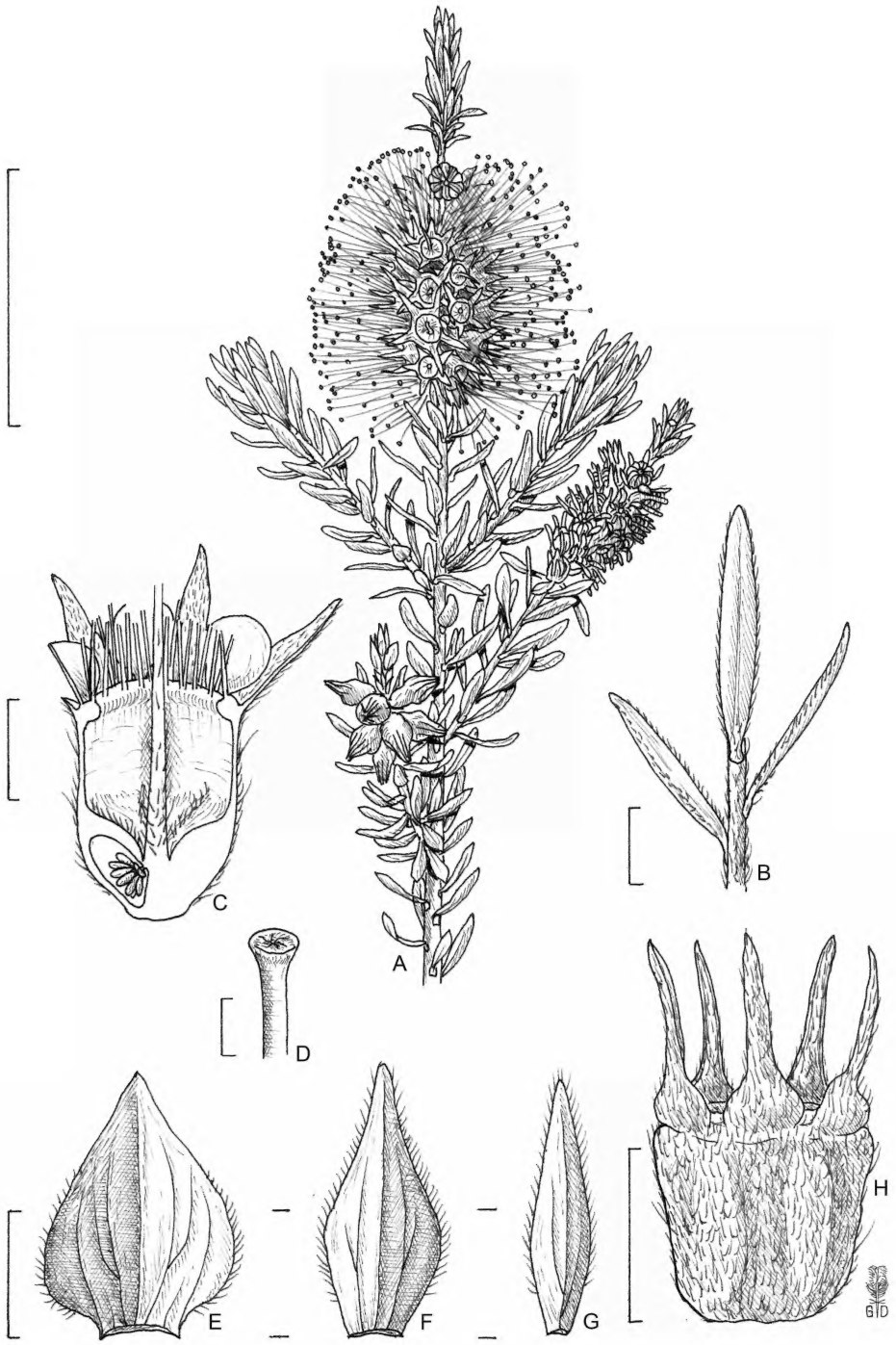


**Fig. 2.** ***K. baxteri***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** flat-topped stigma; **E** perule; **F, G** bracts; **H** fruit. — Scale bars: **A** 5 cm; **B** 3.5 mm; **C** 4 mm; **D** 0.5 mm; **E–G** 2.5 mm; **H** 6 mm – **A**, **B**, **F**, **G** *H.R.Toelken 7861* (AD); **C–E** *L.Haegi 1224* (AD); **H** *L.Haegi 2603* (AD).

be part of that collection, but differ morphologically slightly as one would expect in a population. They are, however, consecutively numbered as was often done with duplicates in MEL.

*Selection of specimens examined (45 seen)*

Western Australia: *T.E.H.Aplin 2615a*, Mt Boyatup, 25.x.1963 (PERTH); *M.I.H.Brooker 3677*, N Twin Peak Is., Recherche Archipelago, 24.v.1972 (CANB); *E.M. Canning CBG35073*, Mt Merrivale, 4.xi.1968 (CANB); *M.D. Crisp 9910 & L.G.Cook*, Tower Pk summit, Mt Ragged Ra., 10.ix. 2005 (CANB); *N.N.Donner 2645*, c. 10 km ESE Howick Hill, 19.ix.1968 (AD, L, PERTH); *C.A.Gardner & W.E.Blackall 1173*, Mt Ragged, 26.x.1931 (PERTH); *L.Haegi 1224*, Condingup Pk, 6.x.1976 (AD, KW, PERTH); *R.Hnatuik 761172*, c. 58 km WNW of Pt Malcolm, 20.ix.1976 (PERTH); *G.J. & B.J.Keighery 5213*, 5 km N Dwellingup, 31.vii.2005 (CANB); *G.Maxwell MEL92501*, Israelite Bay, s.dat. (MEL); sine coll. in Herb. *F.Mueller MEL92500*, Cape le Grande, s.dat. (MEL); *M.E.Phillips CBG10692*, Mt Merrivale, 4.ix.1962 (CANB); *D.J.E.Whibley 5439*, 65 km E Esperance, 14.xi.1974 (AD, PERTH); *J.H.Willis MEL92499*, Mondrain Is., Recherche Archipelago, 13.xi.1950 (MEL, PERTH); *P.G.Wilson 2974*, c. 100 km E Esperance, 11.ix.1964 (AD, NY, PERTH).

Victoria: *J.H.Ross 4146*, Phillip Is., Berry Beach Rd, 1.x. 2004 (MEL); *V.Stajsic 1511*, 10 km NNW Anglesea, Flaxbournes Rd, 3.iii.1996 (MEL).

*Putative hybrids*

***K. baxteri* × *K. pulchella*** (see also Elliot & Jones 1993, p. 17)

Flowering branches are superficially similar to those of *K. baxteri* because the branching is in flushes and the stout floral axis bears sessile or subsessile flowers without obvious bracteoles. However, the whole plant has the more spreading habit of *K. pulchella*, the leaves are greyish-green, oblanceolate, though never obovate, and without marginal rows of hairs, the calyx lobes are broadly triangular and shorter than the petals, and the filaments are relatively short.

In spite of these intermediate characters it could not be established whether it is a hybrid or an interesting but unusual cultivated plant, because neither the growing conditions were fully examined nor could it be traced where the hybridization could have taken place, as in nature the two species never overlap geographically.

*Specimen examined*

South Australia (cultivated): *C.Simpson s.n.*, Kersbrook, 24.vi.1988 (AD) (23% abnormal pollen).

## A.2. *Kunzea* sect. *Floridae* (Toelken) Toelken & de Lange

in de Lange et al., Austral. Syst. Bot. 23: 317 (2010). — *Kunzea* subsect. *Floridae* Toelken, J. Adelaide Bot. Gard. 17: 82 (1996). — **Type species:** *K. affinis* S.Moore.

*Kunzea* sect. '*Eukunzea*' Benth., Fl. Austral. 3: 112 (1867), pro parte, quoad *K. eriocalyx*, *K. preissiana* – nom. inval.

Low shrubs usually smaller than 2 m tall, much branched in seasonal growth flushes; young branches shedding epidermis slough-like. *Leaves* with short lateral (intralateral) veins. *Inflorescence* with (1–) 2–10 (–15) flowers, globular and without terminal leaves, clustered distally with the terminal inflorescence usually subtended by few additional ones on short shoots, vegetative growth resumes after fruiting terminally and/or laterally from below the inflorescence. *Flowers* usually sessile, pink to purple; *stamens* as long as or shorter than petals; *ovary* (2–) 5-locular.

*Discussion*. The ten Western Australian species accepted by Toelken (1996, 2007) differ mainly from the similarly pink-flowered species of sect. *Zeanuk* and subgen. *Kunzea* by their many but smaller inflorescences and relative larger petals, that are about as long as the stamens.

**Key to species and hybrids:** see Toelken (1996: 85) and Table 1 for a list of species.

## A.3. *Kunzea* sect. *Zeanuk* Toelken

J. Adelaide Bot. Gard. 17: 32 (1996), emend., excl. subsect. *Floridae* Toelken. — **Type species:** *K. glabrescens* Toelken.

*Kunzea* subsect. *Arborescentes* Toelken, J. Adelaide Bot. Gard. 17: 32 (1996). — **Type species:** *K. glabrescens* Toelken.

*Kunzea* subsect. *Globosae* Toelken, J. Adelaide Bot. Gard. 17: 53 (1996). — **Type species:** *K. recurva* Schauer.

*Kunzea* sect. '*Eukunzea*' Benth., Fl. Austral. 3: 112 (1867), pro parte, quoad *K. ericifolia*, *K. micrantha*, *K. micromera*, *K. recurva* – nom. inval.

Shrubs or trees 0.2–3 (–5) m tall, branching in seasonal growth flushes; young branches shedding epidermis slough-like. *Leaves* with intralateral veins ± well developed and recurved. *Inflorescence* with (10–) 15–30 (–40) flowers, globular without terminal leaves, usually single and apparently-terminal, vegetative growth continues terminally after fruiting. *Flowers* sessile, white, yellow, pink to purple; *stamens* longer than petals; *ovary* 5-locular, except for 2 or 3 (–5) in *K. micrantha*.

*Discussion*. The concept of sect. *Zeanuk* has been restricted to 13 species of the subsections *Arborescentes* and *Globosae* of Toelken (1996), while subsect. *Floridae* has been raised to an independent section. These Western Australian species have pink to purple or yellow to white globular flowering inflorescences very similar to species of subgen. *Kunzea* from eastern Australia. The two groups are not easily distinguished by a single characteristic, such as the slough-like abscission of the epidermis of mature branches. Other characters common in sect. *Zeanuk* are five locules per ovary, each with rarely up to 16 ovules in contrast to predominantly three locules (each with often up to 50 ovules) in the superficially similar flowers of subgen. *Kunzea*.

**Key to species, subspecies and hybrids:** see Toelken (1996: 33, 54) and Table 1 for a list of all species.

## B. *Kunzea* subgen. *Kunzea*

in de Lange et al., Austral. Syst Bot. 23: 317 (2010). — **Type species:** *K. capitata* (Reichb.) Heynh. (genus & type conserved: cf. Toelken 1981a & b).

*Kunzea* sect. *Salisia* (Lindl.) Benth., Fl. Austral. 3: 115 (1867), pro parte, excl. *K. baxteri* and *K. pulchella*.

*Kunzea* sect. '*Eukunzea*' Benth., Fl. Austral. 3: 112 (1867), pro parte, quoad *K. muelleri* – nom. inval.

Main branches with irregular growth flushes (no short shoots) from some of the axils of the leaves; branches with raised but scarcely decurrent leaf bases, not flanged, with epidermis splitting into long longitudinal ridges or strips becoming ± corky bark often with membranous margins. *Leaves* with apex commonly pinched, with (1–) 3–9 main (intralateral) veins erect. *Inflorescence* an apparently terminal globular botryum with (2–) 5–20 flowers, without terminal leaves when flowering, with growth continuing from terminal bud after fruiting; *bracts* broad and scale-like and chartaceous, usually 3–5 veined, persistent to ± deciduous; *bracteoles* scale-like and chartaceous, persistent or deciduous. *Flowers* sessile, mature buds with rounded apex. *Stamens* equally long, longer than petals, erect to spreading. *Ovary* with 2 or 3 (–5) locules, each with ± peltate placenta with (6–) 10–∞ short spreading ovules and/or 1 to few elongate pendulous ones in some species, e.g. *K. cambagei*; *style* slender and as long as stamens, much longer than the free hypanthium.

*Discussion*. The 13 species included in subgen. *Kunzea* from eastern Australia have very similar usually globose inflorescences with pink to purple, yellow or white flowers and are not easily distinguished from sect. *Zeanuk* (see discussion above). They are mainly restricted to the temperate areas of southern Queensland, eastern New South Wales and Victoria, except for *K. pomifera*, which extends its distribution into coastal South Australia. Unusual in the genus is also the occurrence of *K. muelleri* in subalpine regions of New South Wales and Victoria.

### 26. *Kunzea juniperoides* Toelken, *nom. nov.*

*Agonis ericoides* F.M.Bailey, Queensland Dept. Agric. Bot. Bull. 2: 37 (1891), non *K. ericoides* (A.Rich.) Joy Thomps. (1983). — **Type:** New South Wales, Charleys Forest, *W.Bäuerlen s.n.*, x.1886 (holo.: NSW124243).

*Kunzea sp. B* Joy Thomps. in S.W.L.Jacobs & Pickard (eds), Pl. New South Wales 166 (1981); Peter G.Wilson in G.J. Harden (ed.), Fl. New South Wales 2: 153 (1991), pro max. parte.

Shrublets 0.15–0.6 m tall, suberect to spreading-decumbent, with wiry branches; young branches wiry-woody with leaf bases slightly raised and flanges absent, pubescent to sericeous with fine antrorse appressed hairs; early bark splitting irregularly longitudinally, peeling in irregular oblong flakes. *Leaves* alternate; *petioles* 0.2–0.4 mm long, appressed; *lamina* linear, rarely linear-elliptic, (2.5–) 3.5–8 (–12.3) × 0.4–0.6 mm, scarcely tapering into apex and petiole, straight to slightly incurved, flat to slightly concave and glabrous above, strongly convex below and central vein visible only at the base, glabrous except for long antrorse marginal hairs or rarely sericeous with fine hairs each with a persistent base. *Inflorescence* a sessile botryum with 3–8 (–11) flowers, apparently terminal on little-branched main branches, with terminal vegetative growth continuing after flowering; *retained perules* many, few short proximal broadly ovate ones are acute grading distally into broader-ovate and cuspidate ones, 0.8–3.6 mm long, proximal ones with usually 1 vein and often glabrescent grading into distal ones with at least 5–12 main veins and ± hairy, grading into bracts sometimes with aborted proximal flowers; *bracts* broadly ovate to distally oblong-ovate, 3.1–5.5 × 2.0–4.5 mm, cuspidate, with few to many veins and a pronounced central vein continued into terminal awn, glabrous or with few marginal hairs; *bracteoles* in pairs, oblong-oblanceolate often ± falcate, 3.1–4 × 1.1–1.6 mm, acute to obtuse, folded lengthwise, with one central vein, glabrous or with few marginal cilia. *Hypanthium* 2.8–3.4 mm long when flowering (free tube c. 2 mm long), usually strigose with antrorse appressed hairs. *Calyx lobes* triangular-ovate, 1–1.2 mm, obtuse to rounded, glabrous. *Corolla* lobes obovate to almost orbicular, usually sessile, 1.2–1.4 mm, white. *Stamens* 31–35 in more than one whorl, outer *filaments* slightly longer, 1.6–2.3 mm long; *anthers* broadly ellipsoidal, 0.4–0.5 mm long, with indistinct subterminal gland. *Ovary* 2 (–3)-locular, with style base slightly sunk into the upper surface; *placenta* an almost round disc with off-centre attachment usually on the upper third, scarcely bilobed, each lobe with 1 row of ovules; *ovules* usually 6–12 (–14) per locule, spreading, subequal; *style* 3.4–3.9 mm long, with stigma slightly capitate and scarcely compressed at apex. *Fruit* and *seeds* not seen.

*Diagnostic features.* The white (rarely pink) flowers are erect on small inflorescences surrounded by a large number of broad retained perules and bracts, distinct from all other kunzeas, including the superficially similar *K. dactylota* and *K. muelleri*. Their inflorescences are also borne on a peduncle-like distal branch with much elongated internodes and usually without vegetative axillary short shoots.

*Typification.* As the specific epithet of *Agonis ericoides* cannot be used in *Kunzea*, because it would become a later illegitimate homonym of the earlier *K. ericoides* (A.Rich.) Joy Thomps. (Article 53.1, McNeill et al. 2012), a new name is published here. The type specimen, *W.Bäuerlein NSW124243* as quoted by Bailey (1891) becomes the holotype of the new name.

A very similar specimen, *W.Bäuerlein 163* (MEL 92566), is probably from the same locality, although it was apparently collected one month later. It is, however, accompanied by a field description (a separate label on MEL92566, in German apparently in the collector's hand, cf. K.L.Wilson 1990): "apparently restricted, but where this plant occurs it covers the soil like a thick

**Key to species and subspecies of subgen. *Kunzea***

Hybrids are not included in the key as too little is known about them.

**1.** Ovary with 2 locules
**2.** Petals pink; N.S.W. (ST) . . . . . **26b. *K. juniperoides* subsp. *pernervosa***
**2:** Petals white to yellow
**3.** Leaves linear
**4.** Base of inflorescences obscured by obvious broad bracts
**5.** Bracts subtending inflorescences with 1–3 veins; leaves (2.5–) 4–6 (–7.2) mm long; N.S.W. (ST) . . . . . **26a. *K. juniperoides* subsp. *juniperoides***
**5:** Bracts subtending inflorescences with 4–9 veins; leaves (5.2–) 6.5–8 (–12.3) mm long; N.S.W. (ST) . . . . . **26b. *K. juniperoides* subsp. *pernervosa***
**4:** Base of inflorescence with small bracts
**6.** Petals white; leaves pointed and incurved; N.S.W. (ST) . . . . . **27. *K. dactylota***
**6:** Petals yellow; leaves bluntly acute to obtuse and ± straight; N.S.W. (ST, ACT), Vic. (SNOW) . . . . . **28. *K. muelleri***
**3:** Leaves oblanceolate to elliptic
**7.** Erect shrubs 0.6–1.5 m tall; N.S.W. (CC) . . . . . **31. *K. rupestris***
**7:** Prostrate to decumbent subshrubs up to 0.3 m tall; N.S.W. (CWS?, CT, ST) . . . . . **32. *K. cambagei***
**1:** Ovary with 3 locules
**8.** Petals pink
**9.** Base of inflorescences obscured by obvious broad bracts; N.S.W. (ST) . . . . . **26b. *K. juniperoides* subsp. *pernervosa***
**9:** Base of inflorescence with small bracts
**10.** Leaves opposite to subopposite, linear to conical and straight erect
**11.** Leaves with pronounced central vein, glabrous to sparsely hirsute
**12.** Leaves (0.8–) 1–2.5 (–3.8) mm long; Qld (BN, DD, LE), N.S.W. (NC, NT, NWS) **37a. *K. opposita* var. *opposita***
**12:** Leaves (3.1–) 3.8–5.2 (–5.8) mm long; Qld (LE) . . . . . **37b. *K. opposita* var. *leichhardtii***
**11:** Leaves with central vein usually not visible, sericeous; Qld (NK) . . . . . **38. *K. calida***
**10:** Leaves alternate, oblanceolate to obovate and with recurved or pinched apex
**13.** Leaf apex recurved and abruptly constricted with subterminal abaxial appendage; N.S.W. (CC, SC, NT, CT, ST, NWS, SWS), Vic. (GR, MID, EHL, SNOW, EG) . . . . . **35. *K. parvifolia***
**13:** Leaves with recurved ± pinched apex
**14.** Decumbent shrublet covered with short appressed hairs; N.S.W. (ST) . . . . . **37. *K. badjaensis***
**14:** Erect spreading shrubs covered with fine spreading hairs at least on branches
**15.** Leaves flat except for pinched apex, with 3–∞ main veins and with marginal tubercle; N.S.W. (NC,CC, SC, ST) . . . . . **33a. *K. capitata* subsp. *capitata***
**15:** Leaves folded lengthwise and recurved apex, with 1 (–3) main veins and without marginal tubercles
**16.** Ovary with spreading hairs but free hypanthium and calyx glabrous outside; N.S.W. (CT, ST) . . . . . **33b. *K. capitata* subsp. *seminuda***
**16:** Ovary, free hypanthium and calyx with spreading hairs; Qld (DD, MO), N.S.W. (NT, NC) . . **34. *K. obovata***
**8.** Petals white
**17.** Shrubs decumbent to prostrate
**18.** Shrubs prostrate; leaves obovate, with 3–7 veins; fruit fleshy and indehiscent; Vic. (LMAL, WAN), S.A. (MU, YP, SL, KI, SE) . . . . . **30. *K. pomifera***
**18:** Shrubs decumbent; leaves oblanceolate, with 1 (–3) veins; fruit a dry capsule dehiscing loculicidally; N.S.W. (ST) . . . . . **37. *K. badjaensis***
**17:** Erect spreading shrubs
**19.** Leaf apex recurved and abruptly constricted with subterminal abaxial appendage; N.S.W. (CC, SC, NT, CT, ST, NWS, SWS), Vic. (GR, MID, EHL, SNOW, EG) . . . . . **35. *K. parvifolia***
**19:** Leaves flat or recurved and with pinched apex
**20.** Leaves ± flat except for pinched apex; N.S.W. (NC, CC, SC, ST) . . . . . **33a. *K. capitata* subsp. *capitata***
**20:** Leaves recurved with ± pointed apex
**21.** Calyx and hypanthium glabrous; leaves acute, glabrous except for marginal cilia; N.S.W. (CT, ST) . . . . . **33b. *K. capitata* subsp. *seminuda***
**21.** Calyx and hypanthium pubescent; leaves sharply pointed, pubescent to glabrescent; N.S.W. (CT) . . . . . **30. *K. aristulata***

lawn but not prostrate or decumbent. Ripe fruit were not found/ 6–8 inches high." Plants commonly found on the Pigeon House Range are alltogether larger, erect shrubs up to 60 cm high, have many, usually obvious veins on the large perules and bracts and 10–12 (–14) ovules in each of the three locules. The Bäuerlein specimen is, however, only 15 cm high and forms a thick growth, has usually 1 to 3 veins, commonly incompletely visible on the perules and bracts (cf. fig. 3) and only six ovules in each of its two to three locules per flower. A second label (not in the same handwriting) on that sheet, reads: "Braidwood District / November 1886 / William

Bäuerlen / Nro 163 / Pet. alba / 3,000ft", shows that this collection was made a month later, though presumably from the same locality. A second specimen (MEL92572) with similar basic information on a grey Baron Ferd. von Mueller label is probably a duplicate of the first specimen (MEL92566). While the above two specimens in the Melbourne Herbarium cannot be accepted as types, because of the later collecting date, the field information on them provides important information to interpret the typical subspecies, plants of which were recently rediscovered by R. Miller.

In contrast, subsp. *pernervosa* is a more robust form of the species, which is now better known, because it has recently repeatedly been recorded from the Pigeon House Range between Sassafras and Nerriga. Recognition of this subspecies is, however, complicated, as most specimens record the flower colour as white and/or pink. Some populations (*H.R.Toelken 6872*, *6879*, *6882*, *6883*) examined in the field showed obvious putative hybrids (i.e. with ranges of morphological intermediates: cf. putative hybrids below) with *K. parvifolia*, which was also recorded from area. All plants of the four collections investigated, whether white- or pink-flowered, showed a high percentage of abnormal pollen, usually well over 10%. Another population (*H.R.Toelken 9544*) several kilometres distant also had, though predominantly white-flowered, one plant with white flowers tinged more or less pink. Although this plant showed no morphological intermediates with *K. parvifolia*, nor were any plants of that species observed in the vicinity, and the percentage abnormal pollen count was for plants examined below 10%, only the white-flowered specimen from that locality was taken as the type of the subspecies. It could not be ascertained whether the flower colour of this subspecies naturally varies from the predominant white to pink as in, for instance, *K. badjaensis*, or whether the occasional pink-flowered plants are indicative of wider introgression with *K. parvifolia* or even *K. capitata* subsp. *seminuda*, the only other species present in the area, but not observed in the immediate vicinity of type collection of subsp. *pernervosa*, *H.R.Toelken 9544*.

*Etymology*. The epithet "juniper-oides", Latin, "juniper-like" refers to the spreading needle-like leaves and often untidy, spreading habit resembling miniature horticultural forms of *Juniperus communis*. The more often used "juniperina", also meaning "juniper-like", was avoided here, because it is often used in connotation with colours either of the blue-green leaves or the blue-black fruit, neither of which apply to this kunzea.

**Key to subspecies**

**1.** Bracts subtending inflorescence with 1–3 veins; leaves (2.5–) 4–6 (–7.2) mm long; ovules per locule 6 (–8) . . . . . **26a. *K. juniperoides* subsp. *juniperoides***

**1:** Bracts subtending inflorescence with 4–12 veins; leaves (5.2–) 6.5–8 (–12.3) mm long; ovules per locule (5–) 8–12 . . . . . **26b. *K. juniperoides* subsp. *pernervosa***

**26a. *Kunzea juniperoides* subsp. *juniperoides*.**

*Kunzea muelleri* auct. non Benth.: S.T.Blake, Proc. Roy. Soc. Queensland 69: 79 (1958); Joy Thomps. in S.W.L.Jacobs & Pickard (eds), Pl. New South Wales 166 (1981), pro parte, quoad *Agonis ericoides*.

Shrublet up to 0.2 m tall, multistemmed, with decumbent erect-spreading branches, much branched and forming dense stands. *Leaf lamina* linear, (2.5–) 4–6 (–7.2) mm long, pointed. *Retained perules* of vegetative buds 1–2 (–3) times longer than broad, obtuse to acute, with 1–3 (–5) veins, incompletely visible. *Bracts* oblong-oblanceolate, 3.1–3.4 × 2–2.5 mm. *Ovary* with 6 (–8) ovules. *Flowering*: November. **Fig. 3.**

*Distribution and ecology*. Grows in sandy soil with low heath near Braidwood, New South Wales (ST).

*Conservation status*. Known only from one small population on private property.

*Note*. While the specimen *Bäuerlen 163* is sparsely hairy, material of *J. & R.Miller s.n.* varies from scarcely to densely hairy even on the hypanthium and calyx lobes.

*Specimen examined*

New South Wales: *W.Bäuerlen 163*, [Charleys Forest,] xi.1886 (MEL92566, MEL925721); *J. & R.Miller s.n.*, near Braidwood, 8.xi.2011 (AD, NSW).

**26b. *Kunzea juniperoides* subsp. *pernervosa* Toelken, *subsp. nov.***

*A subspeciei typicae plantis majoribus ad 0.6 m, perulis bractisque pernervosis et 10–12 (–14) ovulis usque ad locule differt.*

**Type:** New South Wales, NNE Nerriga, along Tolwong Road, *H.R.Toelken 9544*, 22.x.2011 (holo.: AD; iso.: BRI, G, K, MEL, MO, NSW, S).

*Kunzea sp. B* Joy Thomps. in S.W.L.Jacobs & Pickard (eds), Pl. New South Wales 166 (1981), pro max. parte; Peter G.Wilson in G.J.Harden, Fl. New South Wales 2: 153 (1991), pro max. parte.

*Kunzea sp. F* de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

*Kunzea sp. Braidwood (Powell 371)* Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales, ed. 2, 2: 176 (2002), pro max. parte

Shrubs up to 0.6 m tall, single- or few-stemmed, with erect spreading branches, sparsely to moderately branched and interwoven into other vegetation. *Leaves* linear, (5.2–) 6.5–8 (–12.3) mm long, pointed. Retained *perules* of vegetative buds (2–) 3–6 times longer than broad, acuminate to cuspidate, with (5–) 8–12 veins well visible to the margins. *Bracts* oblong-obovate, 3.5–5.5 × 2.5–4.5 mm. *Ovary* with 10–12 (–14) ovules per locule. *Flowering*: October, November.

*Distribution and ecology.* Grows in sandy soils on gentle slopes in open patches widely scattered in woodland in scattered populations on the Pigeon House Range, New South Wales (ST) (see also Notes below).

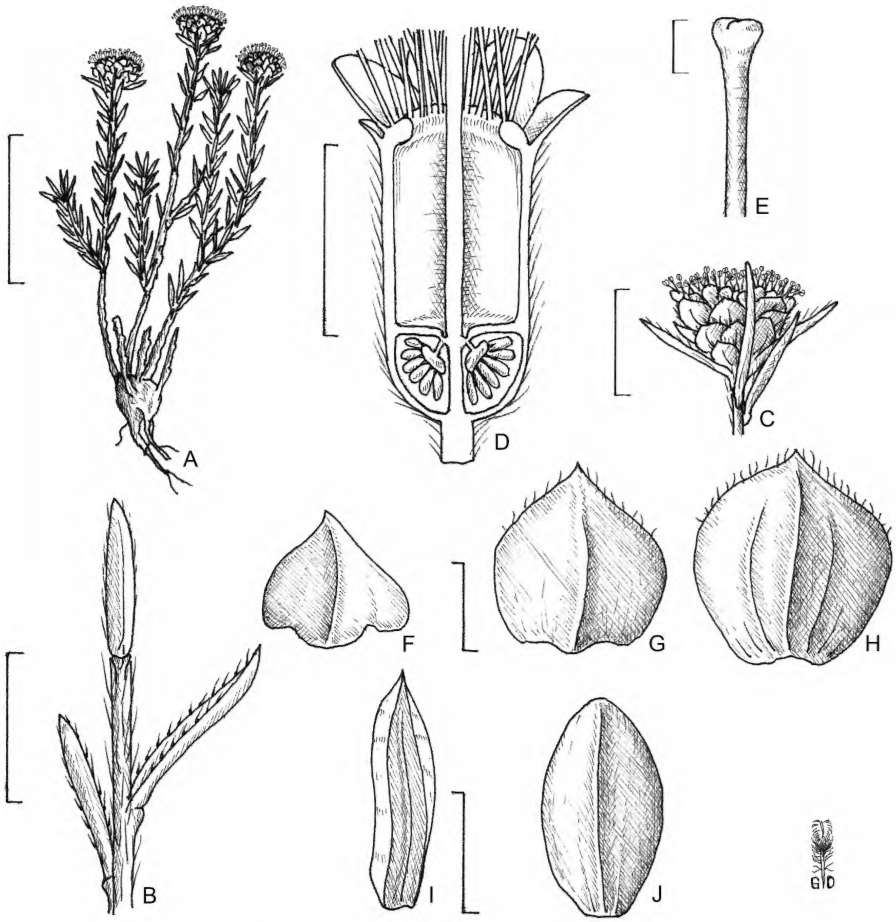


**Fig. 3.** ***K. juniperoides*** **subsp.** ***juniperoides***: **A** flowering plant; **B** cauline leaves; **C** inflorescence subtended by perules and/or bracts; **D** half flower; **E** capitate stigma; **F** perule; **G, H** abaxial view of proximal bracts; **I** abaxial view of distal bract; **J** bracteole. — Scale bars: **A** 3 cm; **B** 3 mm; **C** 10 mm; **D, I, J** 2 mm; **E** 0.5 mm; **F–H** 1.5 mm. — **A–J** *W.Bäuerlen 163* (MEL92566).

*Conservation status*. Rare, populations apparently all conserved in Morton National Park.

*Note*. While the species is usually white-flowered, a few plants with more or less tinged pink petals have also been observed in areas where no hybrids with, or plants of *K. parvifolia* occur (e.g. *H.R.Toelken 9544*).

*Etymology*. The epithet, "pernervosa", Latin, "very much veined" refers to the clearly visible, dense venation with many major veins often more or less raised on the perules, and particularly on the bracts of this subspecies.

*Specimens examined*

New South Wales: *D.Black NSW642839*, Shoalhaven River Trail, 9.iv.1982 (NSW); *C.Burgess NBG9554*, Sassafras, 13.xi.1962 (CANB); *M.G.Corrick 7033*, near Ettrema on Tomrong-Braidwood road, *E.Gauba NBG6222*, (CANB); Pigeon House Ra., 16.xi.1951 (CANB); *V. & C.Murtagh s.n.*, base of Quiltys Mtn, 29.x.1972 (NSW); *J.M.Powell 371 & J.McGrath*, 17.4 km NNE Nerriga, on Tolwong Rd, 7.xi. 1975 (NSW); *F.A.Rodway 12430*, between Sassafras and Mt Ettrema, 16.xi.1941 (NSW); *W.Underwood NSW124244*, between Turpentine and Sassafras, xi.1936 (NSW).

*Putative hybrids*

***K. juniperoides*** **subsp.** ***pernervosa*** × ***K. parvifolia***

The prominent perules and bracts surrounding the flowers and the spreading linear leaves resemble *K. juniperoides*, but rigid and almost twiggy branches and particularly the short shoots below the apparently terminal inflorescences (not peduncle-like as in both subspecies of *K. juniperoides*) are similar to *K. parvifo-*

*lia*. The leaves are also shorter and blunt, similar to those of *K. parvifolia*, although not with an obviously recurved apex. The more or less pink petals and filaments could also be derived from *K. parvifolia*, but white and pink flowers have been recorded from another population of subsp. *pernervosa* (*Toelken 9544*), as well, without apparent morphological similarities to *K. capitata* subsp. *seminuda*, the only other pink-flowered species recorded from the same general area. While three collections of the latter subspecies from near the hybrid swarm show a relatively low percentage of pollen sterility (less than 10%), all white-flowered specimens examined showed a high percentage (more than 20%), so that flower colour cannot be used as a distinguishing character. It is not known how much backcrossing has occurred in these populations, in comparison to a complete range of intermediates recorded by Toelken (1996, p. 59) in a hybrid swarm between *K. recurva* and *K. sulphurea*.

*Notes*. Plants of this hybrid closest to typical *K. juniperoides* subsp. *pernervosa* are those of the collection *H.R.Toelken 6875*, but even they have a relatively high pollen sterility compared to specimens of *K. parvifolia*. The similar cream-flowered collections *H.R.Toelken 6879* and *6881* display a much higher pollen sterility of 53%, but more field work is needed to assess the boundaries of variation of the species as compared to the effect of hybridization (cf. Typification). Furthermore the pollen sterility in all these specimens is unusually high, indicating possible environmental factors in addition to incompatability of the two parent species.

*Specimens examined*

New South Wales: *H.R.Toelken 6872* (pale pink to cream), 12.5 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 64%); *H.R.Toelken 6875* (cream, possibly shade form of typical subsp. *pernervosa*), 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 20–26%); *H.R.Toelken 6879* (cream), 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 53%); *H.R.Toelken 6882* (pale pink to cream), 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 60–67%); *H.R.Toelken 6883* (pink), 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 94%).

*Putative parents from area*

***K. juniperoides* subsp. *pernervosa*** (*H.R.Toelken 6875*, cf. note above). New South Wales: *H.R.Toelken 6881*, 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 14%).

***K. parvifolia.*** New South Wales: *H.R.Toelken 6871* (pink to mauvish-purple), 12.5 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 7%); *H.R.Toelken 6873* (pink to mauvish-purple), 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 3%); *H.R.Toelken 6880* (mauve rarely pink), 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD, NSW; pollen sterility 8%).

### 27. *Kunzea dactylota* Toelken, *sp. nov.*

*A* K. muelleri *floribus albis, lobis calycis acuminatis, staminibus 44–47, 14–16 ovulis in quoque loculis; a* K. juniperoide *perulis paucis et brevioribus, foliis incurvatis et lobis calycis acuminatis differt.*

**Type:** New South Wales, Tinderry Mts, *I.R.Telford 9909*, 9.xii.1984 (holo.: CANB).

*Kunzea muelleri* auct. non Benth.: Peter G.Wilson in G.J. Harden (ed.), Fl. New South Wales 2: 153 (1991).

*Kunzea sp. B* de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

Spreading shrub up to 1.3 m tall; young branches with leaf bases scarcely raised and flanges absent, pubescent with antrorse, ± appressed hairs; early bark peeling in long strips but later breaking into irregular oblong flakes. *Leaves* alternate to approaching opposite when densely clustered; *petioles* 0.2–0.4 mm long, indistinct, ± appressed; *lamina* linear, (3.4–) 5.5–7.5 (–8.6) × 0.4–0.6 mm, acute and with colourless point wearing off to become bluntly acute, rarely obtuse, scarcely constricted into petiole, with margins ± laterally incurved especially towards the apex, above grooved or rarely just concave and with spreading antrorse long fine hairs, glabrescent and becoming verriculose, below strongly convex and hirsute to pubescent with spreading antrorse long fine hairs becoming appressed or wearing off. *Inflorescence* a rounded to elongate botryum with (5–) 7–10 flowers, or elongate distal clusters (superconflorescences) of apparently terminal botrya subtended by 1 to several ± subsessile smaller axillary botrya with 3–5 flowers, distally on branches, with terminal growth continuing after flowering or rarely starting while flowering; retained perules (3–) 5–7, narrowly triangular to broadly ovate or broadly oblong, (0.8–) 1–3 mm long, clasping inflorescence, with central vein continued into a point, rarely rounded with vein scarcely developed, pubescent mainly on membranous margins to glabrescent, deciduous; *bracts* linear-triangular to lanceolate, (4–) 4.5–6.5 × 1–1.5 mm, clasping, with central vein continued into apex, which is often a green and fleshy point, pubescent with ± appressed long fine antrorse hairs and marginal cilia, usually persistent; *bracteoles* in pairs, linear-lanceolate, 3.7–4 × 0.7–0.9 mm, with central vein continued into point, pubescent with membranous margins ciliate, deciduous. *Hypanthium* 3.5–4.2 mm long when flowering (free tube 1.8–2 mm long), usually shorter than bracts, without ridges, pubescent to hirsute with fine long antrorse hairs. *Calyx lobes* triangular, 1.7–2.4 mm long, unequally long, usually longer than broad, pointed and ridged towards the apex, pubescent to hirsute with fine long antrorse hairs. *Corolla lobes* broadly obovate (broader than long) to orbicular, 1.2–1.5 mm long, white. *Stamens* (38–) 44–47 in more than one whorl, *filaments* 2.8–3.3 mm long; *anthers* broadly ellipsoidal, 0.5–0.7 mm long, often with indistinct gland towards the apex. *Ovary* 2 or 3-locular, with style sunk into glabrous upper surface; *placenta* an elliptic disc with central attachment, scarcely bilobed with each lobe with 1 row of ovules; *ovules* (12–) 14–16 per locule, ± spreading; *style* 4.6–5.8 mm long, with stigma truncate, rarely small-capitate and scarcely compressed apically. *Fruit* and *seed* not seen. *Flowering*: November–January.

*Distribution and ecology*. Grows on gravelly slopes or in rock crevices "on a weathered hilltop pavement" in rocky montane heath with *Eucalyptus glaucescens* and *E. pauciflora* or open shrubland at high altitude on peaks of the Tinderry Ranges, but has also been recorded in a depression near Windellama, New South Wales (ST).

*Conservation status*. Conserved in Tinderry National Park where it was recorded locally "very common" (*D. Walker ANU107*).

*Diagnostic features*. Although this species is superficially similar to *K. muelleri*, it is readily distinguished by its verriculose leaves due to remaining tubercled bases of worn-off hairs. The glands on the epidermis of the leaves are scarcely visible as they are not as dark as in *K. muelleri*. Furthermore the apices of the leaves are incurved and the generally longer calyx lobes as well as the greater number of stamens and ovules per locule of *K. dactylota* are usually distinctive. Although the two species are not easily distinguished, molecular studies suggested to adopt species level for *K. dactylota* (de Lange et al. 2010, fig. 1).

The leaves and habit of *K. juniperoides* also resemble those of *K. dactylota,* but the former is distinguished by the compact inflorescence with many large perules clasping its base, straight erect leaves and obtuse to rounded calyx lobes.

*Variation*. *Walker ANU 107* described the habit as "bush about 4 ft high", while *Telford 9909* and others refer to it as a decumbent or spreading shrub. All plants of the disjunct population in a different habitat near Windellama were decumbent and had somewhat smaller leaves and flowers, but these were well within the range of this species as distinct from *K. muelleri*. They were also not exhibiting any distinctive features to warrant infraspecific distinction.

*Etymology*. The epithet "dactyl-ota", latinised Greek, "possessing fingers" refers to the resemblance of the linear leaves to fingers, because in this species the margins are often strongly incurved so that the lamina becomes more or less terete.

*Specimens examined*

New South Wales: *M.I.H.Brooker 5484*, Mt Tinderry, 17.i.1977 (CANB); *R.Johnstone 2841 & G.Errington*, near Windellama, 13.i.2011 (AD, NSW); *D.McVean & E.Dahl ANU8629*, S Tinderry Pk 21.v.1970 (CANB); *R.Miller et al. 2*, near Windellama, 15.xi.2011 (AD, NSW); *S.Podreka 3 et al*., 3.5 km SSW Tinderry Pk trig stn, 14.i.1993 (CANB, NSW); *E.W.Pook CANB209261*, S Tinderry Pk, 29.xi.1970 (CANB); *S.Richmond 6 et al.*, Tinderry Ranges, 12.i.1993 (CANB); *H.Thomson 842 & R.Hyland*, Tinderry Ranges, 2.xii.1982 (CANB); *D.Walker ANU107*, Tinderry Ra., 6.i.1962 (NSW); *J.H.Willis MEL92547*, S Tinderry Pk, 12.i.1970 (MEL).

*Putative hybrid*

***K. dactylota* × *K. parvifolia***

While most plants of this single population of *K. dactylota* have a decumbent habit with wiry-woody branches, a few plants on the one end are distinguished as this putative hybrid, because they have spreading rigid-woody branches up to 1.5 m tall similar to *K. parvifolia*. Furthermore the leaves ((1.6–) 2–3 (–3.8) mm long) are shorter although still oblong-lanceolate, laterally incurved and without double apex similar to *K. dactylota*. The hybrid also has white petals, but all parts of the flowers are much smaller (hypanthium & ovary 2.2–2.4 mm; free calyx lobes ovate and 0.8–1 mm long) as is typical of *K. parvifolia*.

*Specimens examined*

New South Wales: *R.Miller et al. 3*, near Windellama, 15.xi.2011 (AD, NSW).

*Putative parents from the area*

***K. dactylota.*** New South Wales: *R.Miller et al. 2*, near Windellama, 15.xi.2011 (AD, NSW).

***K. parvifolia.*** New South Wales: *C.W.E.Moore 2712*, between Marulan and Tallong, 16.x.1952 (NSW); *L.G.Adams 1978*, 9 mls [14.5 km] NNW Braidwood, 2.xi.1967 (NSW).

### 28. *Kunzea muelleri* Benth.

Fl. Austral. 3: 113 (1867); Maiden & Betche, Census N.S.W. Pl. 154 (1916); Ewart, Fl. Victoria 864 (1931); N.T.Burb. & M.Gray, Fl. Austral. Cap. Territory 268 (1970); J.H.Willis, Handb. Pl. Victoria 2: 449 (1973); Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); Jeanes in N.G.Walsh & Entwisle (eds), Fl. Victoria 3: 1020 (1996). — **Type:** New South Wales, higher rocky regions of the Munyang Mountains, *F.Mueller s.n.,* (lecto., designated here: lower left branch, MEL92321). **Remaining syn.:** Munyong Mountains, *F.Mueller s.n.* (MEL92320, MEL92322, MEL92340, MEL92341); Victoria, Mt Wellington, *F.Mueller s.n.* (K 000843030, K000843031 MEL92323, MEL92324, MEL 92325, MEL92326).

*Kunzea ericifolia* F.Muell., Trans. & Proc. Victorian Inst. Advancem. Sci. 1: 123 (in preprint 1855, cf. Seberg 1986), nom. illeg., non (Sm.) Heynh. (1840); A.D.Chapman, Contr. Herb. Austral. 18: 1–3 (1976). — **Type**: same as for *K. muelleri*.

*Kunzea glabriuscula* Gand. in Bull. Soc. Bot. France 65: 26 (1918); B.G.Briggs in McGill., Contr. New South Wales Natl. Herb. 4: 345 (1973). — **Type:** Victoria, Mt Hotham, *Audas s.n.*, vi.1910 (lecto., selected by McGillivray (1973): LY, n.v., NSW, photo!). **Remaining syn.:** New South Wales, Thredbo River, Mt Kosciusko, *Maiden & Forsyth s.n.* (LY, n.v., NSW, photo!; NSW89804); in monte Kosciusko, *Walter s.n*. (LY, n.v., NSW, photo!).

*Agonis ericoides* auct. non F.M.Bailey: S.T.Blake, Proc. Roy. Soc. Queensland 69: 79 (1958), pro parte.

Spreading shrub 0.3–0.8 (–1) m tall, sometimes rooting along branches; young branches with leaf bases scarcely raised and flanges absent or almost so, pubescent with antrorse appressed hairs; early bark peeling into strips but then forming almost square flakes. *Leaves* opposite or almost so, ± 4-ranked; *petioles* 0.2–0.4 mm long, appressed; *lamina* linear, (2.1–) 2.5–4.5 (–8) × 0.3–0.6 (–0.8) mm, bluntly acute to obtuse, rarely pointed, scarcely constricted into petiole and apex, with margins usually slightly incurved especially towards the apex, above flat to ± concave and usually with spreading

antrorse hairs, below ± strongly convex and puberulous with appressed hairs rarely glabrescent. *Inflorescence* a ± rounded sessile botryum or often apparently terminal cluster of botrya (superconflorescence), each with (1–) 2 or 3 (–5) flowers, apparently terminal on long and short shoots, with terminal growth continuing after flowering; *retained perules* rarely more than 3, narrowly triangular-lanceolate to broadly ovate, 1–1.5 mm long, clasping to basally auriculate, with central vein continued into point, puberulous to glabrescent; *bracts* ovate to lanceolate-acuminate on upper flowers, 3–4 × 1.3–1.6 mm, with stiff central vein continued into point, pubescent with long antrorse hairs; *bracteoles* in pairs, linear-lanceolate to often somewhat falcate, 3–4 × 1–1.5 mm, central vein continued into point, pubescent with long antrorse hairs. *Hypanthium* 3–4 mm long when flowering (free tube 1.8–2.3 mm long) and usually shorter than bracts, without ridges, pubescent to hirsute, with fine long ± antrorse hairs. *Calyx lobes* triangular-ovate, 1–1.6 mm long, obtuse, acute or pointed and ridged towards the apex, pubescent, rarely glabrescent, with fine antrorse hairs. *Corolla lobes* orbicular or almost so, 1.3–1.6 mm long, pale yellow to rarely off-white. *Stamens* 24–35 in more than one whorl; *filaments* 3.5–4.7 mm long; *anthers* broadly ellipsoidal, 0.5–0.7 mm long, with often indistinct gland towards the apex. *Ovary* 2-locular, with style ± sunk into the glabrous upper surface; *placenta* a broad-elliptic disc with central attachment, scarcely bilobed, with each lobe with 1 (2) rows of ovules; *ovules* 6–10 per locule, usually spreading; style 3.7–5.8 mm long, with stigma small-capitate, scarcely compressed at apex. *Fruit* an urceolate capsule with erect calyx lobes. *Seeds* almost cylindrical but ± angular, often somewhat crescent-shaped, 1.3–1.6 mm long, with testa ± hard, brown and with dense vertical ribbing. *Flowering*: November–February. *Common name*: **Yellow kunzea** (Ewart 1931, Willis 1973, Jeanes 1996). **Fig. 4.**

*Distribution and ecology*. Forming often stands in boggy or seepage areas or associated with rock screes, often associated with *Eucalyptus pauciflora* and *E. triplex*, usually in areas somewhat protected from mainly frost in sub- to alpine vegetation in southern New South Wales (ST, ACT) and northern Victoria (SNOW).

*Conservation status*. Locally common and occurring in several conserved areas in Victoria and New South Wales.

*Diagnostic features*. Among species with almost terete leaves with only the base of the central vein visible near the junction of the petiole and lamina on the abaxial leaf surface, such as *K. dactylota* and *K. juniperoides*, *K. muelleri* is distinguished by its usually yellow petals, branches of short shoots are thread-like, and short bracts. The early bark is splitting at first into strips but shortly afterwards they break into almost square flakes, which is unique for species of the subgen. *Kunzea*.

*Variation*. Specimens of *K. muelleri* show an unusually wide range of variation in the size and at times also the shape of various organs, probably due to extreme ecological conditions such plants inhabit. These extreme variations may at time account for a broader concept including the similar species *K. dactylota* and *K. juniperoides*. The normal length of leaves, for instance, does not tend to exceed 6 mm, but at times they do attain a similar length to those of the *K. dactylota* (e.g. *J.Thompson 3066*), but then they are without the terminal colourless point typical of *K. dactylota*. Similarly the calyx lobes of *K. muelleri* may be pointed on some specimens and might resemble those of *K. dactylota*, but they are never as long as those.

Inflorescences on main branches often appear to be distinctly larger, but they usually include 1 or 2 (3) pairs of lateral inflorescences on short shoots from nodes subtending the central inflorescence and thus forming a dense aggregate (cf. Inflorescences).

*Typification*. *Kunzea muelleri* is here interpreted, as it was by Chapman (1976, 1991), as a new name replacing *K. ericifolia* F.Muell., non (Sm.) Heynh., so that it is not only based on the material seen by Bentham. Mueller published the species in early September 1855 (Aston 1984). It seems therefore highly likely that the collection from the Munyang Mountains in "Jan. 55" prompted the description of the species. This is supported by the fact that this collection contains flowering and fruiting material as described, while the collection from Mt Wellington ("circa 1854" according to J.H.Willis on MEL92325) consists of flowering material only. Among the five sheets of the collection from the Munyang Mountains examined, only MEL92321 refers to the higher rocky habitat mentioned in the protologue, and therefore the lower left branch on the sheet was selected as the lectotype. Although irrellevant for the selection of the lectotype, it is useful to observe that this specimen was later seen by Bentham. Mueller's specimens annotated as "K. ericifolia F. Müll. Austral. felix" found in various herbaria could include duplicates of the above syntypes, but without additional information cannot be identified as such. Specimens from the Hydinger Range (e.g. MEL92327 and MEL92328, also marked as seen by Bentham), which are often included among the syntypes, do not qualify, as that locality is not mentioned in the protologue, and specimen MEL92327 states the date of collecting as "March 61", indicating also subsequent collections by Mueller exist and these must be distinguished.

*Selection of specimens examined (152 seen)*

New South Wales: *A.M.Ashby 5481*, Schlink Pass, 28.1.1977 (AD); *W.Bäuerlen NSW124036*, Bulbrock Mtn, iii.1890 (NSW); *N.T.Burbidge 3906*, 2 mls [3.2 km] W Kiandra, 22.ii.1955 (CANB); *I.Crawford 7296*, 3.7 km W Gudgenby trig., Scabby Ra. Nature Res., 10.1.2003 (CANB); *F.E.Davies 486 & S.Walton*, Mt Black Jack, 21.i. 1988 (AD, CANB, NSW); *H.Eichler 13532*, slopes of The Paralyser, 28.1.1957 (AD, E, G); *E.Gauba CBG7233*, near

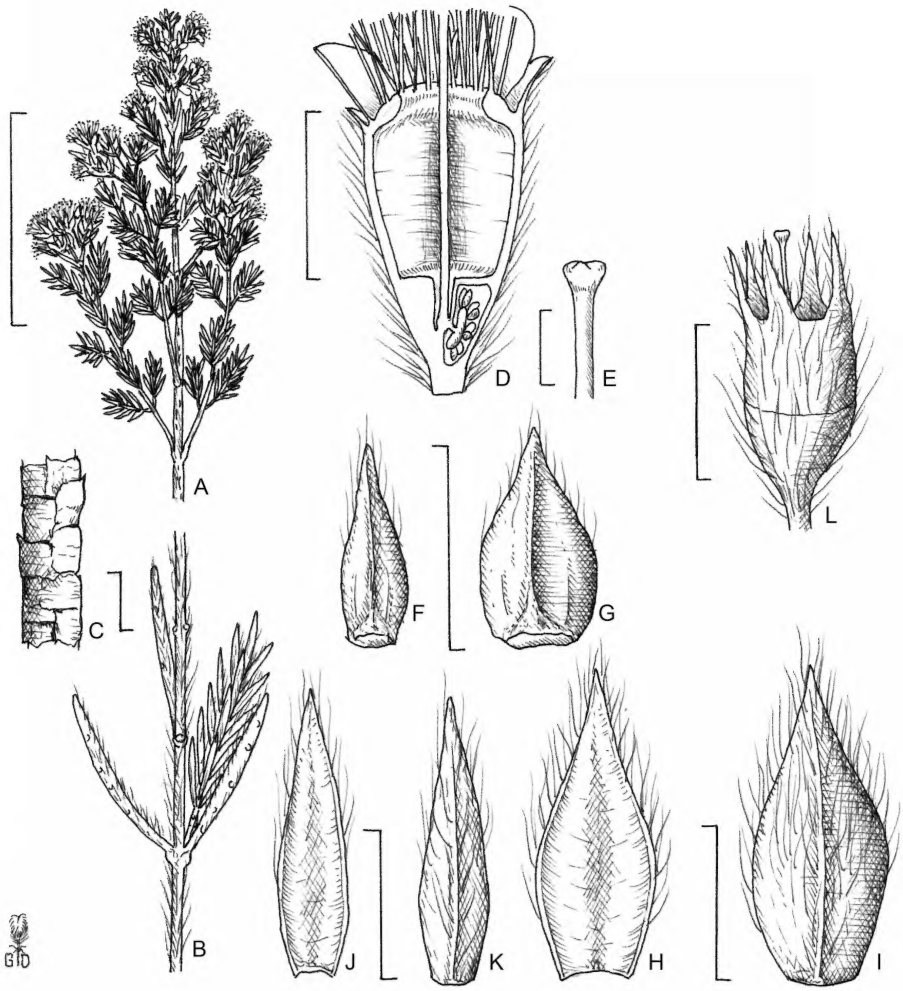


**Fig. 4.** ***K. muelleri***: **A** flowering branch; **B** cauline leaves; **C** young branch displaying scaly bark; **D** half flower; **E** capitate stigma; **F, G** abaxial view of perules; **H** adaxial view of bract; **I** abaxial view of bract; **J** adaxial view of bracteole; **K** abaxial view of bracteole; **L** fruit. — Scale bars: **A** 6 cm; **B, C, J, K** 2 mm; **D** 1.5 mm; **E** 0.5 mm; **F, G** 1 mm; **H, I** 1.5 mm; **J, K** 2 mm; **L** 3 mm. — **A–K** *J.Cullimore 236* (MEL92558); **L** *C.Walter s.n.* (MEL92574).

Mt Kosciusko, 8.i.1950 (AD, CANB); *P.N.Martensz 495*, The Twins near Geehi Reservoir, 8.ii.1972 (CANB, NSW); *B.A.Mumbulla 1*, Yaouk Pk, 9.1.1996 (AD, CANB, NSW); *J.C.Newman NSW124035*, Round Mtn, on the Tumut River catchment, ii.1952 (NSW); *R.W.Purdie 4951*, Kiandra Rd, 1.3 km from Sawyers Hill Rest House, 17.xii.2000 (NSW, CANB); *H.Salasoo 3533*, Khancoban to Geehi, 23.i.1969 (NSW); *G.Stewart 730 et al.*, near Charlottes Pass, 6.ii.1985 (AD, CANB, MO); *I.R.Telford 8585 & M.Parris*, Sentry Box Hill, 14.i.1981 (AD, CANB, NSW, US); *D. Walker ANU1237*, Little Peppercorn Plain, SW Brindabella Ra., xii.1963 (CANB, MEL, NSW); *A.J.Whalen 620 & J.A.Matarzyck*, near Tharwa, SW Booroomba Rocks Lookout, 23.xi.2000 (CANB).

Victoria: *A.C.Beauglehole 15426*, Bogong High Plains, Wilkinson Memorial Lodge, 25.i.1966 (MEL); *A.C.Beauglehole 41586*, Mt Pinnibar, 24.ii.1973 (MEL); *E.M.Canning 1795*, Lake Catani, 15.i.1969 (CANB); *L.A.Craven 1646*, 2 mls [3.2 km] S Mt Feathertop, 23.xii.1969 (CANB); *H.Eichler 14640*, above Falls Creek Ski Village, 31.i.1958 (AD, E, G); *R.Melville & K.Atkins 2641*, Mt Buffalo, 30.xii.1952 (K, MEL, NSW); *M.E.Phillips CBG46277*, Hotham Heights, 10.i. 1973 (CANB); *P.S.Short 1400*, Mt Buffalo, 28.1.1982 (AD, MEL); *J.H.Willis MEL92545*, Mt Speculation, Barry Mts, 2.i.1945 (MEL).

### 29. *Kunzea pomifera* F.Muell.

Trans. & Proc. Victorian Inst. Advancem. Sci. 1: 124 (in preprint 1855, cf. Seberg 1986); F.Muell., Hooker's J. Bot. Kew Gard. Misc. 8: 66 (1856); Miq., Ned. Kruidk. Arch. 4: 146 (1856); Benth., Fl. Austral. 3: 116 (1867); J.M.Black, Fl. S. Austral. 3: 405 (1926); Ewart, Fl. Vic-

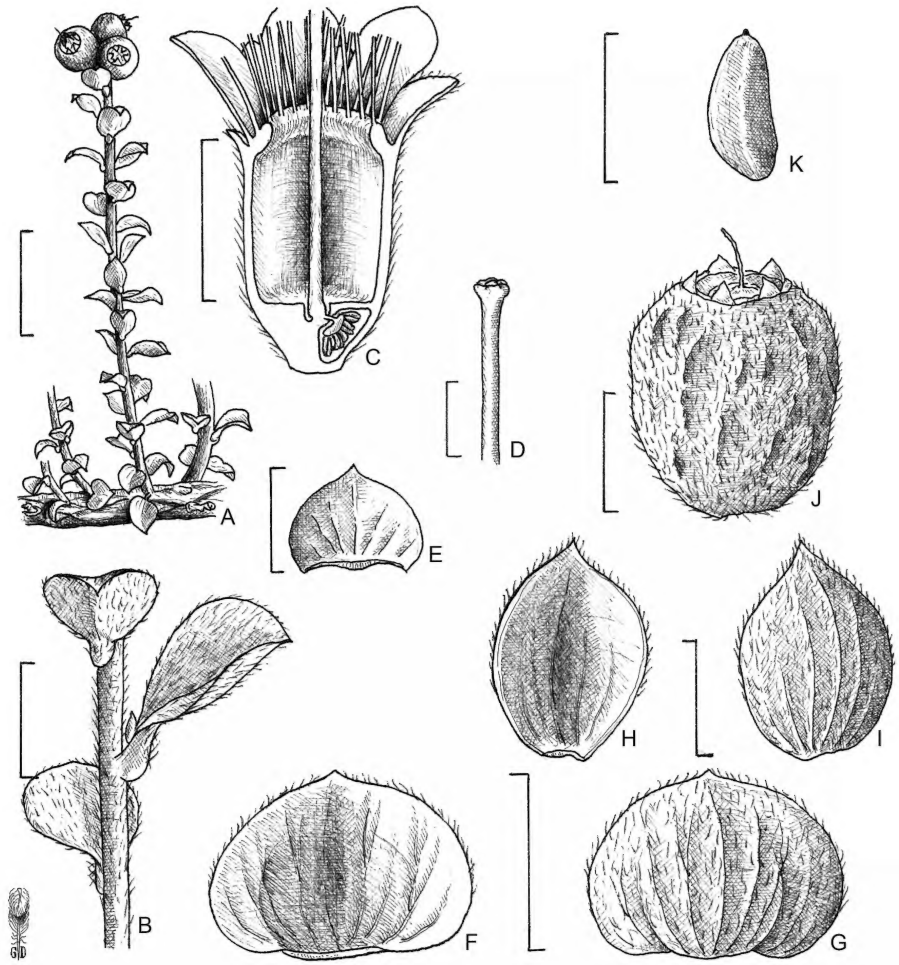


**Fig. 5. A–K *K. pomifera***: **A** lateral fruiting branchlet from prostrate main axis; **B** cauline leaves; **C** half flower; **D** capitate stigma; **E** abaxial view of perule; **F** adaxial view of bract; **G** abaxial view of bract; **H** adaxial view of bracteole; **I** abaxial view of bracteole; **J** fleshy fruit; **K** seed. — Scale bars: **A** 1 cm; **B** 2 mm; **C** 3 mm; **D** 0.5 mm; **E, H, I** 1 mm; **F, G** 2.5 mm; **J** 3 mm; **K** 1.5 mm. — **A–K** *H.R.Toelken 6842* (AD).

toria 864 (1931); J.M.Black, Fl. S. Austral., ed. 2, 3: 604, fig. 802 (1952); J.H.Willis, Handb. Pl. Victoria 2: 449 (1973); Toelken in Jessop & Toelken (eds), Fl. S. Austral. 2: 932 (1986); Jeanes in N.G.Walsh & Entwistle (eds), Fl. Victoria 3: 1019 (1996). — **Type:** South Australia, Holdfast Bay, *F.Mueller s.n.*, 10.xi.1848 (lecto., designated here: MEL92432; isolecto.: dupl. ex Herb. Sonder, MEL 92412); **Remaining syn.:** Rivoli Bay, *F.Mueller s.n.* (MEL 92411, MEL92433–6); Gawler Town, *H.H.Behr s.n.*, 22.xi (MEL92305, MEL92413, W); Sturt River, *F.Mueller s.n.* (MEL92304: β *ovalifolia*) (cf. Typification).

*Kunzea pomifera* α *cordifolia* F.Muell. in Miq., Ned. Kruidk. Arch. 4: 147 (1856), nom. inval., sine descr. (see Typification).

*Kunzea pomifera* β *ovalifolia* F.Muell. in Miq., Ned. Kruidk. Arch. 4: 147 (1856), nom. inval., sine descr.

Shrublets up to 0.3 m tall, decumbent or prostrate, forming patches to 3 m across, often rooting along branches or suckering; young branches with leaf bases slightly raised and scarcely visible, tomentose to puberulous with short spreading to antrorse hairs; early bark splitting into slender strips soon becoming corky but with upper layers often ± peeling especially along the margins. *Leaves* alternate; *petiole* 0.6–1.3 mm long, ± appressed; *lamina* ovate to broad-ovate, rarely lanceolate, elliptic or oblanceolate, (2.6–) 3–8 (–10) × (2.1–) 3–6 (–8.3) mm, acute and somewhat recurved, often abruptly constricted into petiole, concave to cymbiform above, flat to ± convex below, 3–5 (–7)-veined, ± pubescent with antrorse hairs usually appressed, usually with horny, entire to dentate or

crenate margins often ciliate when young. *Inflorescence* a ± rounded botryum with (1–) 3–8 (–15) flowers, apparently terminal mainly on lateral branches, rarely with terminal vegetative growth after flowering; *retained perules* usually numerous, broadly ovate, clasping, 3–10-veined, abruptly rounded and mucronate, rarely emarginate, glabrescent, rarely pubescent; *bracts* broadly ovate, auriculate becoming spathulate-obovate on upper flowers, 2–3.5 × 2–4 mm, obtuse to rounded, 5–∞-veined, pubescent to tomentose with short antrorse hairs on thicker central part, glabrous on hyaline margins; *bracteoles* in pairs, oblong-oblanceolate to somewhat falcate, 2–3.8 × 1–2 mm, central vein continued into acute or mucronate apex, pubescent to tomentose with antrorse hairs. *Hypanthium* 3–4.5 mm long when flowering (free tube 2.5–3 mm), little longer than bracts, puberulous to tomentose with antrorse hairs outside. *Calyx lobes* triangular, 1–1.5 mm long, sometimes ridged towards apex, appressed-pubescent outside, sometimes puberulous inside. *Corolla lobes* obovate-orbicular, usually clawed, (0.8–) 1–1.5 (–1.9) mm long, white to cream. *Stamens* 32–38 (–44), in more than one whorl; *filaments* 5.2–7.5 (–8.6) mm long, somewhat broadened towards the base; *anthers* broadly oblong, 0.35–0.4 mm long, with small red subterminal gland. *Ovary* 3-locular, with style slightly sunk into the glabrous upper surface; *placenta* a round disc with short off-centre attachment on upper third, scarcely bilobed, each lobe with 2 rows of ovules; *ovules* 9 or 10 (11) per locule, spreading or erect above to lower 3 or 4 pendulous and slightly longer; *style* 6.3–8 (–9.4) mm long, with stigma small-capitate, scarcely compressed at the apex. *Fruit* indehiscent, fleshy, with short incurved calyx lobes, deep red to black. *Seeds* obloid to slightly crescent-shaped, 1.3–1.5 (–2) mm long, ± triangular in section, pale brown, smooth and shiny, with hard testa. *Flowering*: October (November); *Common name*: **Muntries** (Black 1926, Ewart 1931, Willis 1973, Toelken 1986, Jeanes 1996). **Fig. 5.**

*Distribution and ecology*. Locally common on sandy soils with or without surface limestone but often on richer soils with clay subsoils in depressions or around lakes, on coastal dunes or on inland localities associated especially with mallee heath, in heath or woodland; found from western Victoria (LMAL, WAN) connecting up with inland distributions and all along much of the coast of eastern South Australia (MU, YP, SL, KI, SE) as far north as near Tanunda and Moonta.

*Conservation status*. Not threatened and often locally common.

*Diagnostic features*. *Kunzea pomifera* vaguely resembles *K. cambagei*, which also has a decumbent habit and indehiscent, though dry fruit, but is distinguished by broader leaves, bracts and bracteoles with 3–10 veins. The deep red to black, fleshy indehiscent fruit, as well as seeds with a hard almost smooth testa of *K. pomifera* are unique in the genus.

*Variation*. Considerable variation in the size, shape and indumentum of the leaves can be observed throughout its range, but also often on one plant depending on vigorous or senescent growth. Their marginal cilia are usually appressed and wear off soon, so that their bases give the leaves a serrulate to dentate appearance.

Perules, bracts and bracteoles vary from deciduous to caducous, so that they are often not visible even in flowering material.

Immature seeds show the long vertical cells typical of kunzea seeds and occasionally they are also slightly ribbed, but as they mature the testa gets hard and smooth unlike seeds of any other species.

*Typification*. Seberg (1986) unravelled the little-known sequence of events of the publication of the name. *K. pomifera* was first published as a preprint of June/July 1855, but reprinted with slight alterations several times subsequently.

When Mueller (1855) described *K. pomifera*, no specimens were cited, so that typification must largely be guided by the date of publication and collections available with special reference to the locality given as "on sandy shores and on rocks at St Vincent's Gulf and Rivoli Bay". The species is here lectotypified on a flowering specimen from Holdfast Bay (on St Vincent Gulf), because it is accompanied by a collector's label with the following note used in the protologue: "K. recurva similis differt fol. 5-nervis venosis subcordatis haud perforatis". The date of collection is well before 1855, though the exact date could not be established, because the collector's label states "flr.10.1848", while the date given on the herbarium label in what seems Mueller's handwriting as 1847. The specimens from Rivoli Bay are accepted as syntypes based on Mueller's direct reference to it, but no collector's date could be found on any of the sheets. While the collecting date for the specimen from Sturt River (*F.Mueller MEL92304*) is missing, the river is also flowing into the Gulf of St Vincent; neither is a full date recorded for Gawler Town, *H.H.Behr s.n.*, 22.xi. (MEL92305, MEL92413), but the collector left South Australia in 1849 (Grandison 1990), so that the specimens are all regarded as original material, as they were available to Mueller at the time of the publication of *K. pomifera*.

It appears that Miquel (1856) also described *K. pomifera* based on a specimen (U66213B) supplied by F. Mueller as he had also done for *K. pelagia* (cf. *K. ambigua*). However, judging by the information about the two variants, α and β, for which Miquel's protologue specifically specifies "varies", Latin, "variant" and not a rank of variety, and without description/diagnosis except for the morphologically derived "epithet" invalidates the names in spite of Article 32.1, Note 1 (McNeill et al. 2012). If they were intended as infraspecific taxa it is not clear which of the two, or how the two differ from the typical form. It is interesting that he quoted for α the specimens from Holdfast Bay and pine forest near Gawler, while for β specimens from Angaston, Stuart

River and Rivoli Bay. The fact that he wrote/copied most of this information on the same label, but published more detail, indicates that these localities were mentioned separately by F. Mueller. A second specimen (U66214B, "Austral. felix") with a label by F. Mueller not in Miquel's handwriting seem to be of a later date.

*Selection of specimens examined (162 seen)*

Victoria: *A.C.Beauglehole 39013*, Swan Lake, Portland, i.1948 (MEL); *A.C.Beauglehole 39016*, S Kaniva, x.1949 (MEL); *D.Albrecht 4710*, Swan Lake, W Mt Richmond, 14.xi.1991 (MEL); *H.E.D'Alton NSW124245*, Nhill, v.1895 (NSW); *C.French MEL92645/6*, NW Lake Albacutya, ix.1887 (MEL); *A.Morton 463*, 0.5 mls [0.8 km] SE Lake Wonga, Wyperfeld N.P., 11.xi.1979 (MEL); *T.B.Muir 5697*, Discovery Bay, NW end of Lake Bong, 27.iii.1978 (MEL); *M.E.Phillips CBG7031*, Mt Richmond N.P., 26.x. 1963 (CANB); *M.E.Phillips CBG12287*, Winniam-Goroke, 10.ix. 1961 (CANB); *M.E.Phillips CBG19124*, 18 mls [28.8 km] N Kaniva, 22.x.1966 (CANB); *J.M.Reader MEL92651*, near Jeparit, 1897 (MEL); *C.Wedding sub A.C.Beauglehole 39937*, Rainbow, x.1945 (MEL); *H.B.Williamson 547*, Lillimur, i.1898 (MEL92650).

South Australia: *J.Carrick 3500*, Scorpion Spring, 26.x. 1973 (AD; E, H, L, n.v.); *J.B.Cleland AD97225013*, N Tea Tree Gully, 6.xii.1947 (AD); *K.Czornij 211*, 3 km W Tepko, 3.x.1968 (AD); *H.Eichler 12214*, Sampsons Flats, 29.ii.1956 (AD); *D.Fotheringham & B.Overton NPKI 30097*, 5 km SE American River, 14.xi.1989 (AD); *E.H.Ising AD966040830*, Bangham Forest, 12.xii.1934 (AD); *E.N.S.Jackson 279*, 16 km NE Lucindale, 21.xi.1959 (AD, AAU, B, NY); *M.Kenny AD 97912065*, Two Wells, 30.x.1962 (AD); *D.N.Kraehenbuehl 1676*, c. 1.6 km NE Tanunda, 8.i.1976 (AD); *B.Nordenstam & A.Anderberg 1080*, 6 km W Coonalpyn, 7.xi.1989 (AD, S); *M.E.Phillips CBG16988*, 23 mls [36.8 km] Bordertown to Keith, 21.x.1966 (CANB); *T.Reichstein 861*, Aldinga, xii.1969 (AD); *T.J.Smith 859*, 0.5 km N Normanville, 16.x.1967 (AD, AK); *A.G.Spooner 5539*, Carpenter Rocks, 5.xi.1977 (AD); *D.E.Symon 8502*, dunes behind Pennington Bay, 27.i.1973 (CANB, K, L, NSW); *R.Taplin 380*, Monarto C.P., 5.viii.1990 (AD); *J.G.O.Tepper AD97225012*, Coromandel Valley, s.d. (AD); *J.R.Wheeler 1362*, Vivonne Bay, 22.x.1968 (AD, NBG, NT); *D.J.E.Whibley 9421*, Cape Buffon, 12.x.1984 (AD, BRI, CBG); *L.D.Williams 5763*, Younghusband Is., 29.ix.1974 (AD); *J.Woodman s.n.*, c. 10 km N Balgowan, i.1987 (AD); *J.W.Wrigley CBG37327*, 27 mls [43.2 km] Tailem Bend to Meningie, 28.xi.1968 (CANB, NSW).

### 30. *Kunzea aristulata* Toelken, *sp. nov.*

*A* K. rupestre *foliis ovatis perrecurvatis aristatis, ovario triloculato c. 50 ovulis differt; a* K. cambagei *et* K. pomifera *habitu fruticis, ovario triloculato c. 50 ovulis differt;* K. capitata *similis sed differt foliis bracteisque aristatis vel aristulatis, calice hypanthioque distale glabro, petalis albis et stigmatibus vix capitatis.*

**Type:** New South Wales, Mt Cookem, *D.H.Benson 4470 & D.Keith*, 21.xi.1985 (holo.: AD98753031; iso.: NSW206204, NSW364129).

*Kunzea sp. E* Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

*Kunzea sp. Mt Cookem (Benson 4470)* Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales, ed. 2, 2: 176 (2002); Pellow et al., Fl. Sydney Region, ed. 5, 203 (2009).

Shrub to 1–2 m tall, spreading; young branches with leaf bases scarcely raised but not in form of flanges, pubescent with short antrorsely curved hairs; early bark splitting longitudinally into irregular strips with upper layers peeling from the margins. *Leaves* alternate; *petioles* 0.6–1 mm long, appressed; *lamina* ovate, (2–) 3.2–6 × 1.5–2.3 mm, ± abruptly tapering into terminal point and petiole, ± strongly recurved, usually slightly folded lengthwise and concave above along the central vein, convex below, 3–5 (–7)-veined, pubescent to glabrescent. *Inflorescence* a rounded botryum, with (3–) 7–15 (–20) flowers, apparently terminal on distal branches (no short shoots), with terminal vegetative growth after fruiting; retained perules numerous, usually broadly ovate, 2–3.8 mm long, clasping, cuspidate to rostrate-acuminate upper ones, 1–3-veined, pubescent; *bracts* broadly ovate to oblong-ovate on upper flowers, 2–2.8 × 0.9–1.2 mm, rostrate, usually 3-veined, pubescent to scarcely hirsute with spreading hairs; *bracteoles* in pairs, linear, linear-falcate, rarely linear-lanceolate, 1.8–2.2 × c. 0.4 mm, acute to pointed, with central vein, pubescent. *Hypanthium* 3.8–4.5 mm long when flowering (free tube 1–1.4 mm), irregularly angled towards the base, pubescent outside. *Calyx lobes* broadly triangular, 1.1–1.8 mm long, acute to pointed and often ridged towards the apex, puberulous to glabrescent. *Corolla lobes* obovate-orbicular, slightly clawed, 1–1.2 mm long, white. *Stamens* 50–54 in more than one whorl; *filaments* 1.9–2.3 mm long; *anthers* broadly ellipsoidal, 0.5–0.6 mm long, with red subterminal gland. *Ovary* 3-locular, with upper surface hairy and longer hairs next to the style base which is not or slightly inserted; *placenta* a round disc with short ± off-centre attachment, deeply lobed at least in the centre, with each lobe with 4 rows of ovules; *ovules* 47–50 per locule, spreading, of equal size; *style* 2.1–5.4 mm long, with stigma scarcely broadened, hardly compressed at the apex. *Fruit* ± urceolate but often slightly angular, with spreading calyx lobes, dehiscent or indehiscent. *Seeds* (immature) obloid-conical, c. 1 mm long, soft testa with long indistinct vertical cells. *Flowering*: October, November. **Fig. 6.**

*Distribution and ecology*. Grows often on cliff edge in open forest of *Angophora costata*, *Eucalyptus oblonga*, *E. punctata*, *E. sieberi* in restricted area north of Yerranderie, New South Wales (CT).

*Conservation status*. Very few plants of this rare species have been recorded from a conserved and very inaccessible area in the Blue Mountains National Park.

*Diagnostic features*. *Kunzea aristulata* is very similar to *K. rupestris* but easily distinguished by its ovate, usually recurved leaves terminating in a more or less awned apex. It has also a 3-locular ovary, while *K. rupestris* shares with *K. cambagei* the 2-locular ovary. It is noteworthy that *K. aristulata* is the only species in this group of three species with the style base slightly sunk into the

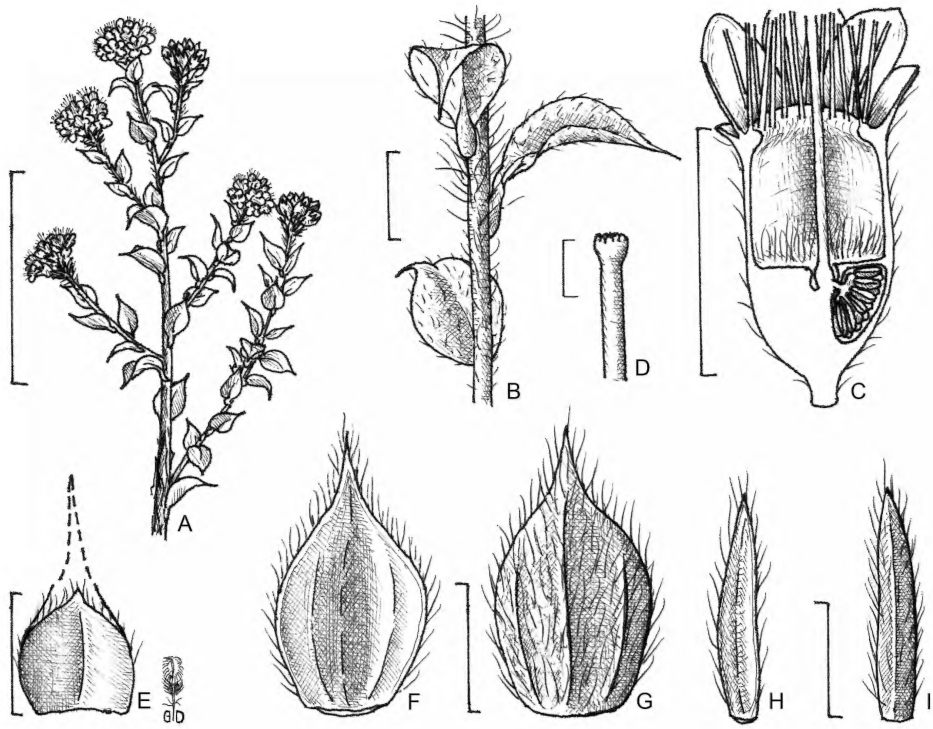


**Fig. 6.** ***K. aristulata***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** scarcely broadened stigma; **E** perule variation; **F** abaxial view of bract; **G** adaxial view of bract; **H** abaxial view of bracteole; **I** adaxial view of bracteole. — Scale bars: **A** 3 cm; **B** 3 mm; **C** 4 mm; **D** 0.5 mm; **E** 2 mm; **F, G** 1.5 mm; **H, I** 1 mm. — **A–I** *A.Fairley s.n.* (NSW 168748).

upper surface of the ovary and the ovary is trilocular with about thirty ovules in each locule.

*Kunzea aristulata* is also superficially similar to *K. capitata*, which also has very much recurved leaves. The latter is, however, distinguished by its oblanceolate to obovate leaves, the glabrous upper surface of the ovary with a distinctly inserted style base and, most importantly, the petals and stamens are pink to purple. In *K. aristulata* the hair bases on the upper leaf margins are distinctly papillate, but such texture is usually not visible in *K. capitata*.

*Notes*. While leaves of the species are usually rigidly recurved, this is not the case on the specimen *M.Kennedy 19, P.Cuneo & A.T.Fairly.*

Fairly (*NSW664289*) comments that crushed leaves have a strong citrus smell.

*Etymology*. Although some leaves are distinctly "awned', Latin, "aristata", many are only shortly pointed, so that the diminutive, "aristulata", seemed more a more appropriate epithet for the species.

*Specimens examined*

New South Wales: *M.Doherty 2*, Axehead Ra., 30.iii. 1986 (NSW); *A.T.Fairly NSW257386*, Sombre Dome, Dicksonia Bluffs, Kanangra Walls, 8.i.1992 (NSW); *A.T.Fairly NSW168748*, Mt Cookem, 21.x.1984 (NSW); *A.T.Fairly NSW664289*, Mt Cookem, 1.ix.2001 (NSW); *W.Jones NSW 265430*, Bulga Ridge, 3.xi.1992 (NSW); *M.Kennedy 19 et al.*, Mt Cookem overlooking Coxs River, 3.x.1990 (NSW).

### 31. *Kunzea rupestris* Blakely

Proc. Linn. Soc. New South Wales 54: 683, pl. 29, 2 (1929); N.C.W.Beadle et al., Handb. Vasc. Pl. Sydney District 290 (1963); N.C.W.Beadle et al., Fl. Sydney Region, ed. 2, 344 (1972); Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); Carolin & Tindale, Fl. Sydney Region, ed. 4, 396 (1993). — **Type:** New South Wales, Hornsby Plateau, near Canoelands, *D.W.C.Shiress & W.F.Blakely s.n.*, 16.x.1929 (lecto., designated here: NSW 124239; isolecto.: BRI40930; K 3 sheets, MEL92309).

Spreading shrub 0.6–1.5 m tall, suckering and apparently clonal; young branches with leaf bases scarcely raised and flanges not developed, pubescent to hirsute, with fine long antrorse hairs; early bark splitting into long ± irregular strips with upper layers peeling in larger or smaller pieces. *Leaves* alternate; *petioles* 0.7–1.1 mm long, appressed; *lamina* oblanceolate, rarely linear-oblanceolate, (6.5–) 7–9.5 × 1.5–2.7 mm, acute to short-pointed, slightly recurved apex, gradually tapering

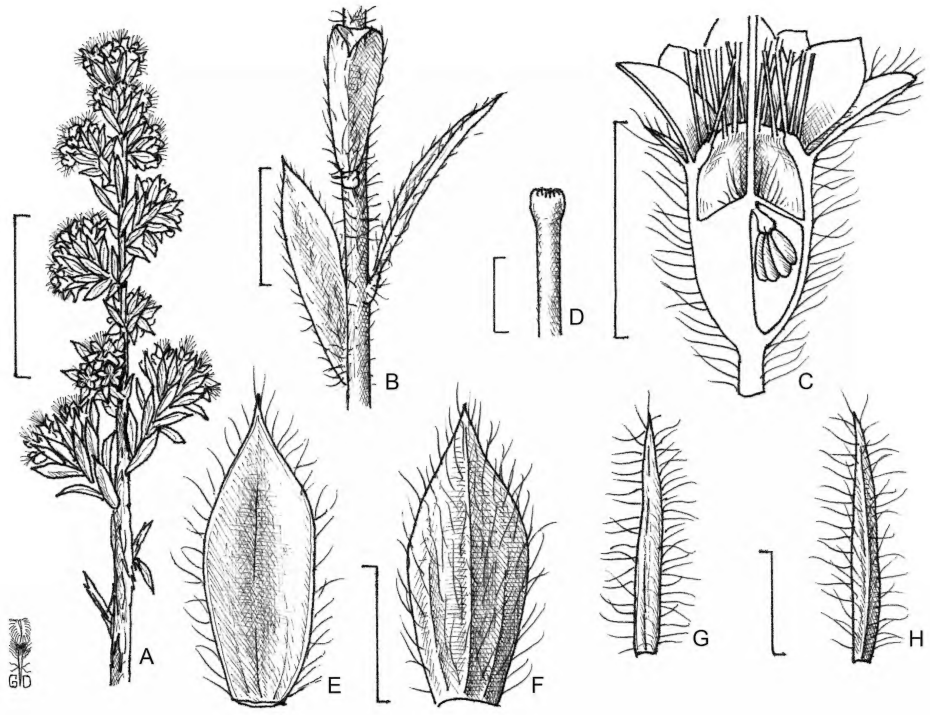


**Fig. 7.** ***K. rupestris***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** scarcely broadened stigma; **E** adaxial view of bract; **F** abaxial view of bract; **G** adaxial view of bracteole; **H** abaxial view of bracteole. — Scale bars: **A** 3 cm; **B** 3 mm; **C** 6 mm; **D** 0.5 mm; **E, F** 1.2 mm; **G, H** 1 mm. — **A–H** *D.W.C.Shiress & W.F.Blakeley s.n.* (NSW124239).

into petiole, concave or slightly folded lengthwise above, convex below, hirsute to rarely villous with long antrorse hairs on both surfaces, to glabrescent mainly on upper half, with papilla-based hairs or papillae along margins. *Inflorescence* a rounded botryum with (3–) 7–19 flowers, apparently terminal on long and short shoots towards end of branches, with terminal vegetative growth continuing after fruiting; *retained perules* (3–) 5 (–7), triangular to ovate-triangular, 1.3–1.8 mm long, usually acuminate, 3-veined, hirsute to glabrescent; *bracts* oblong-oblanceolate, 2–3.2 × 1–1.3 mm, acuminate to mucronate, 3-veined, usually villous with long antrorse hairs; *bracteoles* in pairs, linear-lanceolate to linear on upper flowers, 1.2–2 × 0.2–0.5 mm, with central vein, hirsute to pubescent. *Hypanthium* 2.4–3 mm long when flowering (free tube 1–1.2 mm), rarely ridged, hirsute. *Calyx lobes* often narrow-triangular, 1.1–1.9 mm long, acute to pointed, hirsute. *Corolla lobes* obovate to rhombic-obovate, 0.8–1.2 mm long, white or off-white, ± tinged pink. *Stamens* 25–31 in more than one whorl; *filaments* 4.2–5.4 mm long; *anthers* broadly ellipsoidal, c. 0.7 mm long, with red subterminal gland. *Ovary* 2-locular, with style base gradually tapering into raised centre of upper surface being pubescent and with a tuft of hairs above each locule at base of style; *placenta* conical, tapering gradually central attachment, scarcely bilobed with each lobe with 2 rows of ovules; *ovules* 4 per locule, pendulous; *style* 3.8–5 mm long, slightly broadened towards the base, with stigma scarcely capitate, hardly compressed at apex. *Fruit* ± obconical but often laterally compressed, indehiscent, yellow. *Seeds* obloid-conical, c. 1 mm long, soft testa with indistinct vertical cells. *Flowering*: October (November). **Fig. 7.**

*Distribution and ecology*. Grows on shallow soil on sand stone platforms in heath, often suckering; known only from the Hornsby Plateau, New South Wales (CC).

*Conservation status*. Very rare but conserved in Marramarra National Park. It is regarded as vulnerable in New South Wales (National Herbarium of N.S.W. 2016) and 2VCa by Briggs & Leigh (1996).

*Diagnostic features*. *Kunzea rupestris* is distinguished from the similar *K. aristulata* by its erect oblanceolate leaves, which are scarcely recurved, but also by a bilocular ovary with fewer ovules in each locule. These two species and the decumbent *K. cambagei* share the unusual characteristic of more or less bristly hairs on top of the ovary next to the style base. In addition, the

styles of these species are not, or scarcely in *K. aristulata*, sunk into the upper surface of the ovary. This is a unique feature in the genus, as hairs on the apex of the ovary have also been recorded for other species, e.g. *K. parvifolia*, but then they are short and evenly cover the whole upper surface. While the fruits are indehiscent in *K. rupestris* and *K. cambagei*, but not fleshy as in *K. pomifera*, fruits of *K. aristulata* usually dehisce as is commonly found in all other species of *Kunzea*.

*Variation*. Since the species is known only from the Maroota area not much variation has been recorded, particularly as *P.G.Wilson 184* reports "plants often arising as root suckers".

Fruits are often laterally compressed, because the ovaries are 2-locular with at the most one seed per locule developing.

*Typification*. The specimen NSW124239 with original data is here lectotypified, as the author did not designate a holotype.

*Specimens examined*

New South Wales: *R.G.Coveny 17207b & T.James*, South Maroota, 5.ix.1995 (CANB); *R.Johnstone 2244 & A.E. Orme*, 1 km along Pauls Rd, 20.xi.2007 (CANB); *M.Smith s.n.*, 2.4 km NNE Canoelands Rd, Marramarra N.P., 11.ii. 1993 (CANB); *P.G.Wilson 132 & B.J.Conn*, Marramarra N.P., 22.ix.1987 (AD, CANB, K, NSW); *P.G.Wilson 184 et al.*, Marramarra N.P., 27.xi.1987 (AD, CANB; BM, BRI, K, MEL, MO, n.v.).

*Putative hybrids*

***K. capitata* subsp. *capitata* × *K. rupestris*:** see 33a. *K. capitata* subsp. *capitata*.

### 32. *Kunzea cambagei* Maiden & Betche

Proc. Linn. Soc. New South Wales 38: 246 (1913); Maiden & Betche, Census N.S.W. Pl. 154 (1916); Beadle et al., Fl. Sydney Region, ed. 2, 344 (1972); Peter G.Wilson in G.J. Harden (ed.), Fl. New South Wales 2: 153 (1991); Carolin & Tindale, Fl. Sydney Region, ed. 4, 396 (1993); Pellow et al., Fl. Sydney Region, ed. 5, 202 (2009). — **Type:** New South Wales, "Big Plain" near Mt Werong, *R.H.Cambage 3175*, xii.1911 (lecto., designated here: NSW; isolecto.: BRI). **Remaining syn.:** on the plateau E Mt Werong, *R.H.Cambage 2258*, 4.x.1909 (NSW 3 sheets).

Shrublets up to 0.3 m tall, with decumbent or prostrate branches sometimes rooting along the branches; young branches with leaf bases slightly raised but flanges not developed, ± densely sericeous with silky antrorse hairs; early bark splitting longitudinally as well as transversely, peeling in ± oblong pieces. *Leaves* alternate; *petioles* 0.4–0.7 mm long, appressed or upper third spreading; *lamina* oblanceolate, rarely elliptic, (3.5–) 4–9 × 1.2–3 mm, obtuse to rounded, rarely with slightly recurved apex, gradually tapering into petiole, flat to slightly concave above, ± convex below, usually glabrous above, ± sericeous to glabrescent with long antrorse-appressed hairs mainly below and along the margins. *Inflorescence* a rounded botryum with (3–) 5–13 (–16) flowers, apparently terminal on main branches and below on short lateral shoots or short shoots, or apparently terminal on lateral branches to decumbent main branches, with terminal vegetative growth after fruiting; *retained perules* 2, 3 (–5), ovate to broadly ovate, 1–1.3 mm long, stem-clasping, usually 5-veined, ± densely covered with long silky hairs; *bracts* broadly ovate at base becoming oblong-elliptic on distal flowers, (1.6–) 1.8–2.4 × 2–2.8 mm, usually 3-veined, sericeous with long antrorse hair and shorter marginal cilia; *bracteoles* in pairs, oblanceolate, linear to linear-falcate, 1.2–1.9 × 0.3–0.6 mm, with central vein, sericeous. *Hypanthium* 2.6–3 mm long when flowering (free tube c. 1.3 mm), sericeous. *Calyx lobes* triangular, 0.7–0.9 mm long, acute to obtuse, sericeous. *Corolla lobes* obovate to orbicular, 1.2–1.4 mm long, white or cream. *Stamens* (20) 21–25, often apparently in one whorl; *filaments* 1.7–2.8 mm long; *anthers* broadly ellipsoidal, 0.4–0.5 mm long, with red or yellow, small subterminal gland. *Ovary* 2-locular, with style base gradually tapering into the raised conical centre of the upper surface, being pubescent and with a tuft of longer hairs on a red spot above each locule at the base of the style; *placenta* conical, tapering gradually into the attachment, scarcely bilobed with each lobe with 1 ovule; ovules 2 per locule, pendulous and elongate; *style* 3.1–4.8 mm long, with stigma scarcely capitate, hardly compressed at apex. *Fruit* ± funnel-shaped (obconical) with erect calyx lobes, indehiscent, dry. *Seeds* obloid-ellipsoid, c. 1 mm long, scarcely compressed, smooth. *Flowering*: October, November (December). **Fig. 8.**

*Distribution and ecology*. Known from moist places in heath-like vegetation, sometimes in open eucalypt woodland, associated with sandstone outcrops mainly from the southern Central Tableland (CT) of New South Wales, but has also been recorded further north from one locality near Mudgee (CWS) and to the south near Braidwood (ST).

*Conservation status*. The species is nowhere common, but is conserved in the Blue Mountain National Park (Mt Werong). It is regarded as vulnerable in New South Wales (National Herbarium of N.S.W. 2016) and 2VCa by Briggs & Leigh (1996).

*Diagnostic features*. The prostrate habit, together with the broadly conical upper surface of the ovary continuing into the style without its base being inserted into the ovary, easily distinguish *K. cambagei* from the similarly prostrate *K. pomifera*, which has in addition fleshy fruit. Unique are also, observed at least in the Medway population, the red spots each with a tuft of hairs on top of each locule next to the style. Similar tufts of hairs are, however, also found in the very similar but shrubby *K. rupestris*, but without the red spots on the upper surface of the ovary. *Kunzea cambagei* has also only two pendulous ovules per locule, a character used by Bentham (1863) to separate mainly Western Australian species into his sect. *Eukunzea*, but a reduction of locules and the number of ovules has been

shown to have developed several times and in different infrageneric groups (cf. Flowers).

*Variation*. Plants known from a single record from mountain tops south of Mudgee, which is very much further north, have not been recollected in past fifty years. This and a recent record of the species from near Braidwood are interesting extensions of distribution, particularly as the plants are indistinguishable from the main central populations.

*Typification*. The protologue enumerates two of Cambage's collections and the one from December 1911 is here selected as the lectotype, as it was essential for the description of the species, because it represented the first flowering specimen collected.

*Specimens examined*

New South Wales: *D.Benson 2441 & D.Keith*, Loombah Plateau, 20.xi.1985 (AD; NSW, PERTH, n.v.); *R.Coveny NSW 124236*, SE Mt Werong, 18.ix.1967 (NSW); *T.A.James NSW 436609*, above Wombat Ck, 18.iv.1999 (NSW); *R.Johnstone 2333 & A.E.Orme*, Yerranderie Rd, 30 km SE Oberon at Big Plain, 21xii.2007 (CANB, NSW); *W.B.Marsh NSW124235*, Lock Catherine coal mine, W Berrima, 29.x.1961 (NSW); *W.Martin CBG37933*, Bowral [sic], s.dat. (CANB); *R. & J.Miller 5*, near Braidwood, 8.xi.2011 (AD, NSW); *P.Ollerenshaw 1802*, 6.5 km E Mt Werong on road to Bindook Highlands, 21.x.1988 (AD, CANB, NSW); *L.G.Sweeney NSW 124237*, Meroo, S Mudgee, 17.x.1967 (NSW); *P.G.Wilson 60 & J.Highet*, Loombah Plateau, E Mt Werong, 15.i.1986 (AD; BRI, CANB, MEL, NSW, PERTH, n.v.).

*Putative hybrids*

(i) ***K. cambagei*** × ***K. capitata*** subsp. ***seminuda***

The plants being described as two to three feet high immediately associate them with *K. capitata* and not with the decumbent plants of *K. cambagei*. The flat oblong-oblanceolate leaves, with or without scarcely pinched leaf apex, are similar to those of *K. cambagei*, but they are densely covered with long hairs, as are the branches, similar to *K. capitata* subsp. *capitata*. These hairs are appressed as in *K. cambagei* where they are, however, short and sparse. The small flowers are also reminiscent to those of *K. cambagei* and they even bear some bristles on the convex apex of the ovary, but unlike that species they usually have three locules, each with seven or eight mainly pendulous ovules (two pendulous ovules in each of two locules in *K. cambagei*). The retained perules, bracts and bracteoles are similer to those of *K. cambagei*. The fact that the leaves are flat and the flowers regularly hairy throughout, suggests that one putative parent may be *K. capitata* subsp. *capitata*, but as at present no specimens of it have been recorded from near that area, as that subspecies occurs predominantly in coastal areas, the hybrid is placed under *K. capitata* subsp. *seminuda*, until experimental evidence to refute this assumption can be provided.

*Specimen examined*

New South Wales: *S.Calneck 9*, Berrima River, s.dat. (MEL92506).

*Putative parents from the area*

***K. cambagei.*** New South Wales: *W.B.Marsh NSW124235*, Lock Catherine coal mine, W Berrima, 29.x.1961 (NSW).

***K. capitata* subsp. *seminuda.*** New South Wales: *C.L. Porter 9 et al.*, W edge of Wanganderry Plateau, N. Wombean Caves Rd, W Mittagong, 28.xi.1994 (AD, CANB, NSW).

**(ii) *K. cambagei* × *K. parvifolia***

No hybrid swarm but only three unusual plants outside the range of variation of *K. cambagei* are suspected putative hybrids, as they were found in the Medway population where *K. parvifolia* grew nearby. These are described as two separate entities (A, B), as they were observed, but it is possible that the two forms will in time form a continuous range of variation in a larger backcrossing hybrid swarm. Two specimens of form A combine pale pink flowers with a decumbent habit, while the third plant in a different part of the population of *K. cambagei* had pale yellow flowers and a more erect habit.

***K. cambagei* × *K. parvifolia* A**

Shrubs with main branches decumbent and young branches covered with short appressed hairs. *Leaf lamina* linear-oblanceolate, (1–) 2.2–3.6 × 0.6–1.4 mm. *Bracts* ovate to broadly oblong, usually with rostrate to acuminate, often keeled apex, and with cuneate base on upper flowers; *bracteoles* narrowly spathulate to linear-oblanceolate. *Hypanthium* shortly tomentose outside, free tube longer than ovary. *Ovary* 2-locular, each with 8–10 ovules, upper surface hairy, style base not raised.

*Specimens examined*

New South Wales: *H.R.Toelken 6848*, near Medway, 29.x.1986 (AD, NSW); *H.R.Toelken 6865*, near Medway, 4.xi.1986 (AD, NSW)

***K. cambagei* × *K. parvifolia* B**

Shrubs with few main branches erect and many short lateral branches particularly at the base, and young branches covered with short appressed hairs. *Leaf lamina* oblanceolate, (3–) 3.5–5.5 (–6) × 1.2–2 mm. *Bracts* lanceolate to oblong-lanceolate, acute, not keeled; *bracteoles* linear-falcate or rarely linear-oblanceolate. *Hypanthium* sericeous at the base gradually becoming pubescent below and on the calyx lobes; free tube about as long as ovary. *Ovary* 2-locular each with two ovules, with upper surface hairy, style base raised.

*Specimens examined*

New South Wales: *H.R.Toelken 6847*, near Medway, 29.x.1986 (AD, NSW).

*Putative parents from the associated area*

***K. cambagei.*** New South Wales: *H.R.Toelken 6846*, S Medway, 29.x.1986 (AD).

***K. parvifolia.*** New South Wales: *E.Gordon NSW124082*, Berrima, 15.xi.1961 (NSW); *H.R.Toelken 6845*, S Medway, 29.x.1986 (AD).

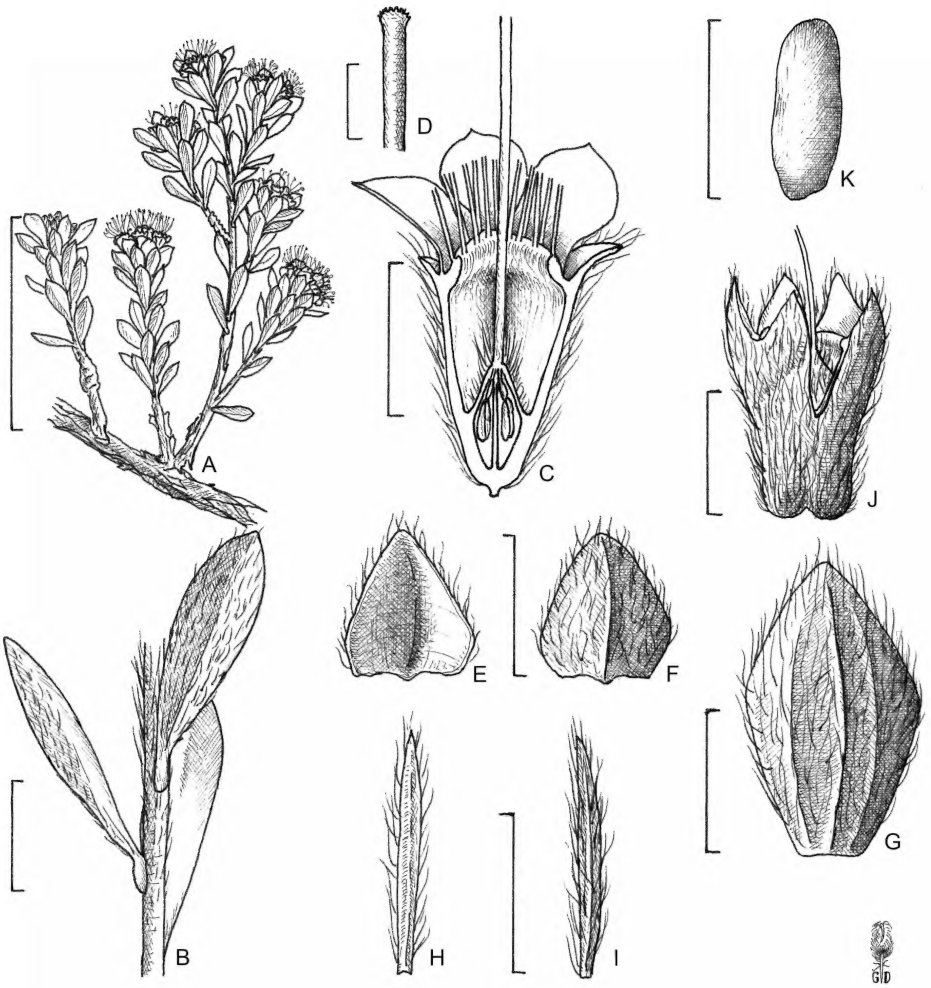


**Fig. 8.** ***K. cambagei***: **A** flowering lateral branches on prostrate main branch; **B** cauline leaves; **C** half flower; **D** scarcely broadened stigma; **E** adaxial view of proximal bract; **F** abaxial view of proximal bract; **G** abaxial view of distal bract; **H** adaxial view of bracteole; **I** abaxial view of bracteole; **J** fruit; **K** seed. — Scale bars: **A** 3 cm; **B** 2 mm; **C–K** 1 mm. — **A–K** *H.R.Toelken 6846* (AD).

### 33. *Kunzea capitata* (Sm.) Rchb. ex Heynh.

Nomencl. Bot. Hort. 1: 337 (1840); Benth., Fl. Austral. 3: 116 (1867); N.C.W.Beadle et al., Handb. Vasc. Pl. Sydney District 290 (1963); N.C.W.Beadle, Student Fl. N.E. New South Wales 3: 477 (1976); Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); Carolin & Tindale, Fl. Sydney Region, ed. 4, 396 (1993); Pellow et al., Fl. Sydney Region, ed. 5, 202 (2009). — *Metrosideros capitata* Sm., Trans. Linn. Soc. London 3: 273 (1797); Sm. in Rees, Cycl. 23: *Metrosideros* no. 15 (1818); DC., Prodr. 3: 225 (1828). — *Callistemon capitatus* (Sm.) Rchb., Iconogr. Bot. Exot. 1: 59, t. 84 (1827), "Callistemma". — *Stenospermum capitatum* (Sm.) Sweet, Hort. Brit., ed. 2, 201 (1830), nom. inval., 3 spp. sine descrip. generico; *S. capitatum* (Sm.) Sweet ex Heynh., Nomencl. Bot. Hort. 2: 787 (1841). — **Type:** New South Wales, near Port Jackson, *J.White* (holo.: LINN–HS877/19; possible iso.: "Smith missit" in Herb. Ventenat, G00223381).

Shrubs 0.5–1.5 (–2.5) m tall, ± erect-spindly to much-branched and spreading; young branches with leaf bases slightly raised and without flanges, pilose to hirsute, rarely pubescent, with spreading, but often ± crisped long and short hairs each sometimes with basal tubercle; early bark splitting mainly longitudinally and peeling at first in long chartaceous strips but soon also break transversely into oblong pieces with ± irregular margins rarely more than one layer thick. *Leaves* alternate; *petiole* (0.2–) 0.7–1.2 (–1.6) mm long, often

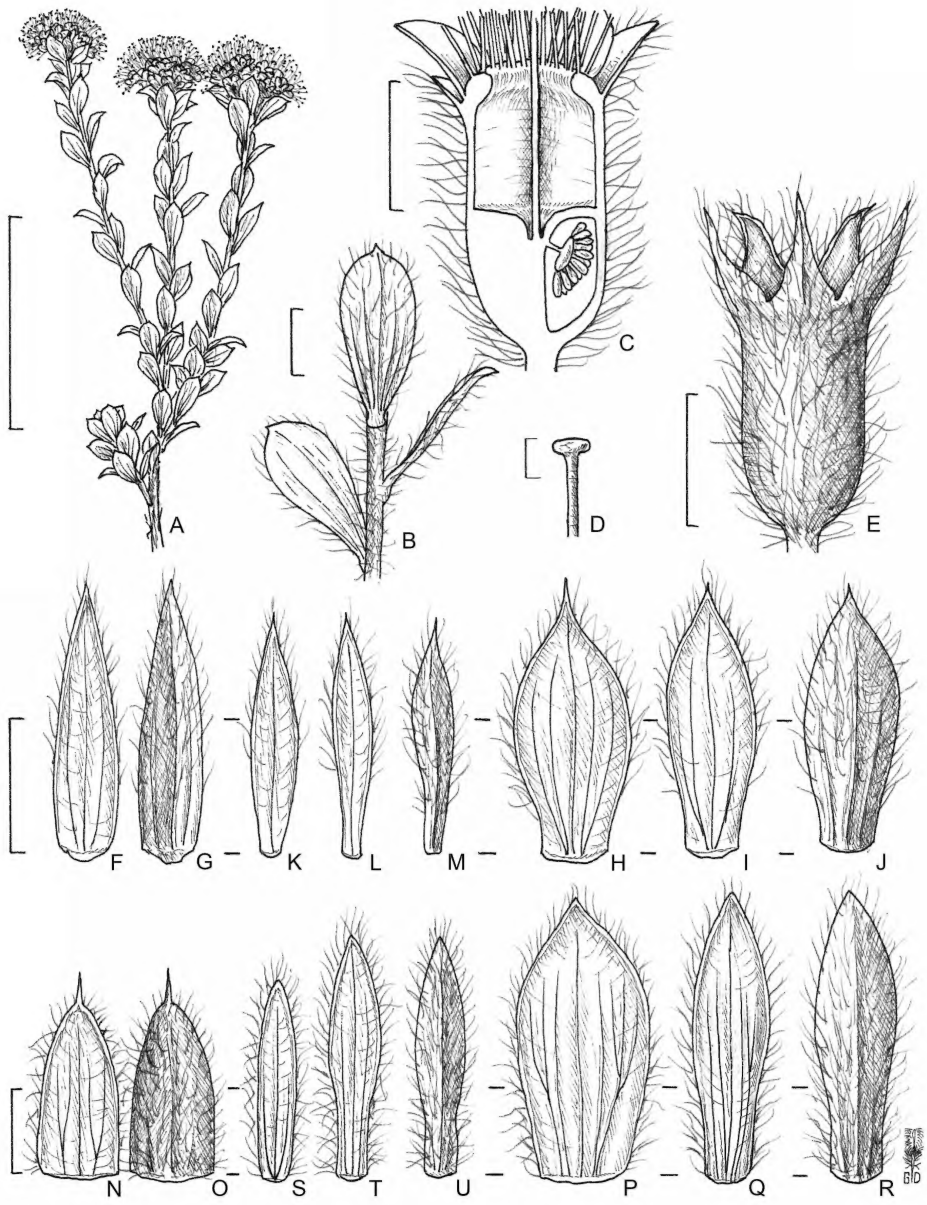


**Fig. 9.** ***K. capitata*** **subsp.** ***capitata***: **A–M** northern form: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** capitate stigma; **E** fruit; **F** adaxial view of perule; **G** adaxial view of perule; **H** adaxial view of proximal bract; **I** adaxial view of distal bract; **J** abaxial view of distal bract; **K, L** adaxial view of bracteoles; **M** abaxial view of bracteole. **N–U** southern form: **N** adaxial view of perule; **O** abaxial view of perule; **P** adaxial view of proximal bract; **Q** adaxial view of distal bract; **R** abaxial view of bract; **S, T** adaxial view of bracteoles; **U** abaxial view of bracteole. — Scale bars: **A** 5 cm; **B** 3 mm; **C** 2.5 mm; **D** 1.5 mm; **E** 3.5 mm; **F–M** 1.5 mm; **N–U** 1.3 mm. — **A–D, F–M** *J.J.Fletcher NSW123953*; **E** *F.A.Rodway NSW123967*; **N–U** *R.H.Cambage* 1415 (NSW).

appressed; *lamina* oblanceolate to oblong-obovate or narrowly to broadly elliptic, rarely linear-oblanceolate, (2.1–) 4.5–9.5 (–14.4) × (1.2–) 2–4.5 (–7.5) mm, ± abruptly constricted into recurved acute apex, usually gradually tapering into petiole, flat and erect to spreading with only the apex recurved, or folded length-

wise and recurving from at least the middle, above flat to furrowed and usually glabrous or rarely with a few hairs, below flat or convex and ± hairy, 3–5 (–9)-veined, with marginal cilia often with ± developed persistent tubercles. *Inflorescence* a rounded botryum, sometimes in clusters with up to 3 sessile lateral ones subtending the distal one, often half-hidden by leaves below, each with (3–) 7–15 (–24) flowers, apparently terminal mainly on major branches, often also on short shoots along distal branches but separate from the main inflorescence, with terminal growth usually after flowering; *retained perules* 2 or 3 (–5), linear-triangular to triangular, (1.2–) 1.4–2 mm long, (1–) 3 (–5)-veined, pilose to hirsute or with spreading crisped hairs mainly towards the apex; *bracts* oblong-elliptic to oblong-oblanceolate, (2.3–) 2.6–3.5 (–3.8) × 0.4–1.2 (–1.6) mm, acute, acuminate, cuspidate to rarely obtuse, (1–) 3–5 (–9) veined, pilose to hirsute, ± glabrous towards the base; *bracteoles* in pairs, linear, linear-elliptic, sometimes falcate, (1.4–) 1.6–2.3 × 0.2–0.4 mm, hirsute. *Hypanthium* 2.4–3.2 mm long when flowering (free tube 1.1–1.6 mm long), hirsute to pubescent, or with glabrous free tube, with spreading or crisped hair on the ovary. *Calyx lobes* narrow-triangular, (1.1–) 1.3–1.8 (–2.2) mm long, acute or pointed and ridged, hirsute to glabrous. Corolla lobes broadly obovate to oblong-obovate or almost orbicular, 1.2–1.6 mm long, scarcely erose, purplish-pink, rarely pink or white. *Stamens* (39–) 45–65 (–75), in more than one whorl; *filaments* (2.6–) 3–4.5 (–5.8) mm long; *anthers* broadly ellipsoidal, 0.4–0.7 mm long, with small subterminal gland. *Ovary* 3-locular, with style base slightly sunk into the upper surface of ovary; *placenta* a broadly elliptic disc with short central attachment, scarcely bilobed, with each lobe with usually 4 rows of ovules; *ovules* 39–54 per locule, spreading, subequal; *style* 4–5.5 (–6.2) mm long, with stigma small capitate, scarcely compressed at apex. *Fruit* elongate urceolate, with erect calyx lobes. *Seeds* ± angular obovoid, 0.5–0.65 mm, with few vertical ridges and some transverse ones joining them.

*Diagnostic features*. *Kunzea capitata* is very variable with a number of local forms, of which only the subsp. *seminuda* is formally segregated here on the basis of its folded leaves without marginal tubercles and glabrous free hypanthium and calyx lobes. Most of the specimens of *K. capitata* subsp. *capitata* with more or less flat leaves are easily distinguished from other kunzeas by their prominent and often more than three veins (up to 9) visible on the abaxial leaf surface. *Kunzea parvifolia* and *K. obovata* have similar folded leaves to subsp. *seminuda*, but the first species has smaller leaves with a double-pointed apex. *Kunzea obovata* differs from *K. capitata* subsp. *seminuda* by its hairy hypanthium and usually some hairs on the upper surface of the ovary surrounding the style insertion. The leaves of *K. badjaensis* are also somewhat similar, but the decumbent plants have short and more or less appressed hairs on branches and leaves.

*Variation*. In contrast to Bentham (1867), who described *Kunzea capitata* var. *glabrescens* from "between Port Jackson and Sydney" based on plants with "calyx glabrous or nearly so", it was found that the density of the indumentum on different parts of this species varies considerably. More material now available showed that his delimitation could not be supported by additional characters and, most importantly, was geographically and edaphically inseparable from the typical variety. The more or less appressed oblanceolate leaves show that it is also not a hybrid with *K. ambigua*, as such specimens also show a decreasing indumentum on the free hypanthium and calyx lobes (cf. *K. ambigua*: putative hybrids).

However, the absence of hairs on the free hypanthium and calyx lobes is also observed on plants from the Central and Southern Tableland, and, as they differ from populations of the coastal plants (NC, CC, SC), they are here described as subsp. *seminuda.* In addition to this character, namely the absence of hairs on older flowers (often common to both subspecies), the segregation of subsp. *seminuda* is also based on its characteristically folded and spreading cauline leaves (± flat except for "pinched" recurved apex and erect to often approaching appressed leaves of subsp. *capitata*), which are usually glabrous, except for marginal hairs without basal tubercles (± hairy at least abaxially and with obvious marginal cilia with basal tubercles in subsp. *capitata*). In herbarium specimens the main veins of the leaves are usually not or only scarcely visible, while they are more or less pronounced in subsp. *capitata*. The full range of variation is discussed in detail under each of the two subspecies.

### Key to subspecies

Local intermediates between the two subspecies are attributed to hybridization at the interface of their distributions (cf. Putative hybrids under *K. capitata* subsp. *capitata*).

**1.** Leaves flat except for recurved "pinched" apex, with marginal tubercles; free hypanthium and calyx outside with spreading hairs to glabrescent . . . . . **33a. *K. capitata* subsp. *capitata***

**1:** Leaves folded lengthwise and recurved in the upper third, without marginal tubercles; free hypanthium and calyx outside glabrous . . . . **33b. *K. capitata* subsp. *seminuda***

### 33a. *Kunzea capitata* subsp. *capitata*.

Benth., Fl. Austral. 3: 116 (1867); Maiden & Betche, Census N.S.W. Pl. 154 (1916), emended.

*Melaleuca thymoides* Sieber, *Fl. Mixta 609* (1836), nom. nud., nom. illeg., non Labill. (1806) (cf. *Sieber 609* in MEL92427, MEL92428, MEL92429).

*Melaleuca eriocephala* Sieber ex Spreng., Syst. Veg. 3: 336 (1825). — **Type:** New South Wales, *F.W.Sieber*, *Fl. Nov. Holl. 322* (lecto., designated here: W340039; isolecto.: K000843020 (right hand side), MEL92427, MEL92430, MEL92520, W177967, W340038, W343372, W).

*Kunzea schaueri* Lehm. ex Schauer in Lehm., Pl. Preiss. 1: 124 (1844), nom. illeg., with *Metrosideros capitata* in synonomy. — **Type:** Nov. Holland, *F.W.Sieber s.n.* (lecto., designated here: W ex. Herb. Endl.). **Remaining syn.:** Nov. Holl., King George's Sound, *F.L.Bauer s.n.*

(W); Australasia orient., *K.K.A. von Hügel 40* (W); South Head road, *K.K.A. von Hügel 97* (W); South Head road, *K.K.A. von Hügel 259* (W); Australasia NSW, *K.K.A. von Hügel s.n.* (W) (cf. Typification).

*Kunzea hirsuta* Turcz., Bull. Soc. Imp. Naturalistes Moscou 35(2): 326 (1862). — **Type:** "Nowa Hollandia", *J.Brogden s.n.* (holo.: KW, n.v.; photo.: PERTH).

*Kunzea capitata* var. *glabrescens* Benth., Fl. Austral. 3: 116 (1867); Maiden & Betche, Census N.S.W. Pl. 154 (1916). — **Type:** New South Wales, between Port Jackson and Sydney, *R.Brown [J.J.Bennett 4659].* (lecto., designated here: BM; isolecto.: K000843021, cf. Typification).

Spreading shrubs up to 2.5 m tall, usually with few to many stems. *Leaves* elliptic-oblong, rarely oblong-lanceolate, (3.8–) 7–10 (–14.4) × (1.2–) 2.5–4.5 (–7.5) mm, flat and erect except for "pinched" recurved apex, with 3–5 (–9) main veins usually visible, above glabrous or rarely with few hairs, below hirsute but soon wearing off, with marginal cilia each with persistent basal tubercle. *Calyx lobes* acuminate to acute, about once to twice longer than broad, and as well as free hypanthium and ovary covered with silky spreading hairs usually > 1 mm long. *Flowering*: September–November (December). **Fig. 9.**

*Distribution and ecology*. Grows on sandy soils usually of old coastal dunes but often associated with temporarily swampy areas and recorded mainly from heath (rarely on forest floor) along the coast and the adjoining foot hills of eastern New South Wales (NC, CC, SC, ST).

*Conservation status*. The subspecies is widespread and locally common.

*Variation*. The variation of *K. capitata* subsp. *capitata* can be divided vaguely into three forms and extreme specimens of each of these are usually easily recognised, but they ultimately grade seamlessly into one another. In contrast to subsp. *seminuda*, the first two forms of subsp. *capitata* can neither morphologically nor geographically or edapically be clearly separated.

(1) North of Sydney the often spindly shrubs are multi-stemmed and have erect flat leaves with only the "pinched" apex, which is acute to usually cuspidate and more or less recurved (fig. 9B). The three to five main veins from the short petiole are more or less visible and marginal tubercles, with or without their hairs, are usually arranged in one row. Leaves are, in contrast to those of subsp. *seminuda*, usually hairy on the abaxial surface and margins, but occasionally very hairy specimens exhibit also hairs on the adaxial surface (e.g. *J.L. Boorman NSW123928*).

The flowers of this northern form of subsp. *capitata* are subtended by long acute lanceolate-triangular retained perules, oblanceolate bracts and linear-elliptic bracteoles (fig. 9K–M). The densely hairy flowers have pointed calyx lobes, which are up to almost twice as long as broad, and, as they are often more sparsely hairy and being more exposed than the basis of the flower, are more likely to become glabrescent sine the hairs wear off above sooner (e.g. *M.F.Day CANB102354* or *T. Reichstein AD966071683*).

These specimens resemble the specimen *R.Brown [J.J.Bennett 4659]*, the type of *K. capitata* var. *glabrescens* Benth., which also has glabrescent rather than glabrous calyx lobes. However, three specimens from Parramatta in MEL deserve more attention, as they were examined by Bentham (signed) and might have swayed his decision to describe the above variety, although they were not cited by Bentham (1867). The specimen *W.Woolls MEL92512* is typical *K. capitata* with densely hairy calyx; on *MEL92513* the calyx is glabrescent, and *W.Woolls MEL92517* has glabrous upper flowers and agrees in all its characters with *K. capitata* subsp. *seminuda*. However, subsp. *seminuda* has never again been recorded so close to Sydney, so that it is here assumed that the locality Parramatta is a reference to W. Woolls' residence (Home et al. 1998) rather than to the provenance of the specimens. Unusual are also specimens from near Morisset (*H.C.Dorman NSW 123979*) and Coffs Harbour (*C.T.White 7427*), which are almost completely glabrous including the flowers, but the flat and more or less strongly veined leaves readily identify them as *K. capitata* subsp. *capitata*. Some glabrous plants with particularly small leaves (c. 4 mm long) have usually marginal tubercles (e.g. *H.Spencer NE9523*) or occasionally no tubercles (e.g. *H.A.Edwards NE9528*).

(2) Plants growing mainly on old dunes from Manly south to Currarong, just north of Jervis Bay, and again further south at Ulludulla are shrubby, much more robust and have usually much broader, often truncate leaves (up to 7.5 mm broad) with marginal tubercles not arranged in rows. Some plants (e.g. *H.Deane NSW 123956)* exhibit these broad leaves at the base and the distal leaves are smaller and especially narrower and therefore resemble those of northern populations. Their similar hairy flowers have often pale pink to white petals (e.g. *R.H.Cambage 4115, 4128*, Ulladulla) and are subtended by ovate-triangular retained perules with usually cuspidate apex, obovate to oblanceolate bracts and bracteoles. All of these perules and bracts as well as the leaves have usually many pronounced main veins (fig. 9N–U). In spite of these distinctive feature the first two forms merge seamlessly and without evidence of hybridization in and around Sydney.

(3) A pronounced change in the local variation can be noticed along the lower Shoalhaven River and the Clyde River, and especially in the vicinity of the Beecroft Peninsula, where the two subspecies come naturally into contact with one another, so that an extensive hybrid population as well as presumed introgression (cf. putative hybrids below) was observed. For instance, all plants examined at Bundanoon (*Toelken 9558*) have glabrous calyx lobes and hypanthium and glabrous leaves, which are more or less folded

and with one scarcely visible central vein (typical of subsp. *seminuda*), while a more eastern population at Carrington Falls (see *K. capitata* subsp. *capitata* × *K. capitata* subsp. *seminuda*) shows the wide range of variation of all these characteristics expected in hybrids of the two subspecies. Some populations from this area show an unexpected large range of variation and identification of the two subspecies and their hybrids becomes very difficult, presumably because of additional introgression. The phenomenon is further complicated by additional local hybridization between the two subspecies and *K. parvifolia* and *K. ambigua* (cf. putative hybrids below).

*Typification. Kunzea capitata* was lectotypified as the type of the genus (Toelken 1981), because of the obvious capitate stigma as cited by Reichenbach (1828). The type specimen of ***K. capitata*** (in LINN) is a broad-leaved specimen from the south-central parts of the distribution of the species. The hypanthium as well as the calyx are densely hairy. A possible isotype inscribed "Smith missit" is located in Herb. Ventenat (G). No lectotypes were selected for *K. capitata* and *K. ambigua* as it cannot be assessed, whether the specimens sent by Smith to Ventenant were authentic duplicates, particularly as it had become fashionable in Europe to grow Australian plants from early exploration of the new continent (Morley & Toelken 1983, p. 14).

***Melaleuca thymoides*** was used without description by Sieber for the specimens of *Fl. Mixta 609* and, as he provided no indications that he was referring to the species of that name by Labilliere (1806), it is an illegitimate later homonym apart from the fact that it was never published.

***Melaleuca eriocephala*** remains an enigma because Sprengel (1826) places it into his group "Foliis oppositis verticillatisque", but neither of these characters apply to any of the specimens of *Sieber 322* or any other Sieber collection of *Kunzea* examined. Nor is the brief description sufficiently detailed to identify the species, but could apply to *Sieber 322* except for the grouping. The only connection to this collection is the cited epithet in the protologue "eriocephala Sieb.", a name Sieber seems to have used for that particular collection, as many specimens were annotated subsequently with that name. However, the collector's number is not cited in the protologue. As no specimen of the type collection could be traced in B, where a major part of Sprengel's personal collection was later sold to (Stafleu & Cowan 1986), it must be assumed that the holotype was destroyed. None of the duplicates of the specimen *Sieber 322* examined bear any indication that Sprengel had referred to them, nor was a specimen found that bore the name *Melaleuca eriocephala* in Sieber's hand as indicated in the protologue. Consequently, with all duplicate specimens being similarly devoid of references to any wordings in the protologue, the specimen W340039 is preferred as lectotype, because it is accompanied by a small label ("NH/ 322. Callistemon capitatus Rbch") in a handwriting similar to other Sieber specimens. The branch on the left is designated as the lectotype.

In the protologue of ***K. schaueri*** three collectors, "Ferd. Bauer! Sieber! Hügel!" are cited and in W six unnumbered specimens of these, annotated as *K. schaueri*, are accepted here as syntypes, particularly as the annotation is written in a distinctive style, similar to other specimens described by Schauer. With everything being equal the specimen, which most closely agrees with the protologue, with leaves obviously 5-veined and "obovato-oblongis cuneatisve" is a Sieber specimen (ex Herb. Endlicher), of which the right hand branch was selected as the lectotype. It is, however, interesting that all these specimens were originally inscribed "*K. smithii*", which is obviously indicating that Schauer was not aware of Heynhold's combination of *Metrosideros capitata* in *Kunzea*. As the description in Schauer (1844) is very similar to those of other species of that particular group of species, it becomes evident that Schauer had presumably intended to publish this species as "*K. smithii*", but Lehmann edited it, with or without Schauer's agreement, to *K. schaueri*. Authorship of the species should therefore be cited as "Lehm. ex Schauer in Lehm." as suggested by Chapman (1991).

A photograph of the holotype of ***K. hirsuta*** examined by the author was sufficiently clear to be able to identify *K. capitata* subsp. *capitata*.

As no specimen of the type collection *R.Brown [Bennett 4659]* examined by Bentham was annotated by him as ***K. capitata* var. *glabrescens***, the specimen at BM is here lectotypified, as he would have consulted this material. A specimen of this collection at K is a duplicate, which was according to the label only distributed and incorporated there in 1877 and thus much later than Bentham (1867) published this part of *Flora Australiensis*. As the specimen agrees in all respects with the protoloque, it is considered an isolectotype.

*Selection of specimens examined (c. 170 seen)*

Many specimens from ST and SC are also cited associated with hybrids: *K. capitata* subsp. *capitata* × subsp. *seminuda*, in order to show the range and number of putive hybrids in that area.

New South Wales: *J.Armstrong 11*, 1.2 mls [1.9 km] from light house to Arakoon, 25.viii.1972 (NSW); *J.Armstrong 1165 & J.M.Powell*, Crowdy Bay N.P., 29.ix.1977 (NSW); *Beckler MEL92515 & 92516*, Hastings River, s.dat. (MEL); *W.Best NSW123977*, Hastings River, viii.1901 (NSW); *W.F.Blakely NSW123925*, Maroota, 14.ix.1929 (NSW); *W.Bäuerlen 414*, Shoalhaven, i.1884 (MEL); *J.L.Boorman NSW123928*, Morrisset, ix.1907 (NSW); *J.L.Boorman NSW123973*, Coffs Harbour, ix.1909 (NSW); *R.Brown [Bennett 4657]*, Georges River, 1803 (MEL 92511); *R.H.Cambage 1415*, Milton, 4.xii.1902 (NSW); *R.H.Cambage 4115*, old racecourse at Ulladulla, 7.xi.1914 (NSW); *R.H.Cambage 4128*, Ulladulla, 9.xi.1914 (NSW); *A.Cameron NSW123980*, Broomes Head, x.1966 (NSW); *E.Cheel NSW123920*, Cronulla, x.1910 (NSW); *C.C.Connolly NSW123976*, Port Stephens, x.1905 (NSW); *M.Craig CBG12596*, Kariong, 6.ix.1965 (CANB); *P.Croucher CBG20233*, Dobroid Pt, 27.x.1960 (CANB); *H.C. Dorman NSW123979*, Old Wyce Rd, Morrisset, 30.x.1962

(NSW); *H.A.Edwards NE9528*, Smoky Cape, viii.1947 (NE); *M.Evans 2718*, near Carrington Water Falls, 16.xi.1967 (AD; A, BISH, BO, CANB, CHR, E, L, LE, NSW, US, n.v.); *J.J.Fletcher NSW123954*, Narrabeen, 8.x.1887 (NSW); *R.H.Goode 41b*, Kuring-gai Chase, 27.x.1954 (NSW); *R.H.Goode 507*, Captain Cooks Pt, Kurnell, 11.xi.1961 (NSW); *W.H.Harvey NSW123982*, Port Jackson district, c. 1850 (NSW); *P.Hind 5336 et al.*, Llandilo Rd, Castlereagh S.F., 7.x.1987(AD; HO, NSW, n.v.); *R.Lemberg NSW123924*, North Head, viii.1937 (NSW); *E.J.McBarron 20377*, The Basin, Georges River, 3.i.1972 (NSW); *Rev. Canon Michael 1987*, Dee Why, 1929 (NSW); *A.Morrison 5/145*, N.P., Sydney, 3.x.1896 (AD); *M.Parris 9791*, c. 5 km SSW Ulladulla, adjacent to Dolphin Point Village, 21.x.1990 (CANB); *M.E.Phillips CBG18856*, near Diamond Head, 23.ix.1966 (CANB); *J.M.Powell 1095 & J.Armstrong*, Crowdy Bay N.P., 29.ix.1977 (NSW); *J.Pulley 815*, Yarramundi, 28.ix.1971 (CANB); *T.Reichstein AD966071683*, N.P., Sydney, 5.x.1961 (AD); *J.F.Roberts MEL92753*, Watsons Bay, 1886 (MEL); *F.A.Rodway NSW123966*, Cambewarra, 29.i.1939 (NSW); *R.Siegert MEL92726*, Port Jackson, 1884 (MEL); *H.Spencer NE9523*, Woy Woy, Gosford Rd, 10.ix.1960 (NE); *I.R.Telford 3645*, Carrington Water Falls, 12.xi.1973 (CANB); *sine coll. NSW123941*, Manly, ix.1903 (NSW); *C.T.White 7427*, Coffs Harbour, 6.x.1930 (BRI).

*Putative hybrids*

**(i) *K. ambigua* × *K. capitata* subsp. *capitata*:** see 48. *K. ambigua*

**(ii) *K. capitata* subsp. *capitata* × *K. capitata* subsp. *seminuda***

As subsp. *seminuda* does not show much variation and occurs in a smaller, less disturbed environment, it is more easily defined, so that the discussion is here viewed from its perspective to measure change believed to be due to hybridization and/or subsequent introgression with a very variable *K. capitata* subsp. *capitata*. There is evidence, through mainly a few old specimens, for direct hybridization on the Kings Tableland (see also variation: *K. capitata* subsp. *seminuda*) and putative hybrids and wider introgression in the vicinity of Wentworth Falls by a range of characters such as flat leaves, with hairs abaxially and/or marginal tubercles as well as the occurrence of hairs on the hypanthium and calyx lobes of the flowers (e.g. *A.A.Hamilton NSW123986*).

Similar hybrid swarms, especially from Carrington Falls, have also been recorded among the southern collections, although typical subsp. *seminuda* is much less frequently known from the Southern Tableland (ST), as most of the specimens show a varying degree of hybridization and/or introgression, because the two subspecies often occur in adjoining but usually different habitats on the foot hills (cf. variation: subsp. *seminuda*). Although *K. capitata* subsp. *capitata* usually occurs in coastal localities especially on old sand dunes, a number of inland specimens (e.g. *I.Olsen 2873*, northern Budawang Range; *T. & J.Whaite 2945*, S Sassafras on Clyde River) seem to indicate that subsp. *capitata* has migrated up the rivers and must be identified as such. These specimens show varying numbers of characters typical of the subsp. *capitata.*

The two localities, near Carrington Falls and south of Sassafras to Tianjara Falls, from where several collections record such a wide range of variation that hybrid swarms are presumed to occur there, because they include specimens showing a full range of characters between the subspecies. Identification of the subspecies and hybrid here remains arbitrary, as no recessive/dominant character in either of the two subspecies could be discerned on which sharp divisions between the taxa could be based, as was previously used to distinguish the putative parents from the putative hybrid *K. recurva* × *K. sulphurea* (Toelken 1996, p. 59). However, specimens of *K. capitata* subsp. *seminuda* have slightly broader leaves with few veins showing at the base in the south-east as compared to their counterparts on the Central Tableland. Furthermore it is important to note that *K. capitata* subsp. *capitata* now also established itself on inland localities away from sand dunes by what must be interpreted as "introgressive adaptation".

*Specimens examined*

New South Wales: *M.P.Austin & J.Duggan 16*, c. 12 km S Sassafras, 9.xii.1972 (CANB); *M.P.Austen 203*, 14 km SE Nerriga, 26.vi.1973 (CANB); *B.G.Briggs & D.F.Blaxall 74*, 4 mls [6.4 km] SSE Sassafras, 7.xii.1968 (NSW); *B.G.Briggs NSW123997*, 1.5 mls [2.4 km] SW Tianjara Falls, 23.xii.1961 (NSW); *E.F.Constable NSW52388*, Pt Perpendicular, Jervis Bay, 8.x.1960 (NSW); *E.Gauba CBG7229*, Jervis Bay, 21.x.1951 (CANB); *E.Gauba CBG9534*, Pigeon House Ra., 2.xi.1951 (CANB); *P.Gilmour 5317*, Brooks Plateau near Tallowa Dam, 23.xi.1985 (CANB); *E.Gordon NSW123999A*, Barren Grounds, xi.1961 (NSW); *E.Gordon NSW123400,* 3 mls [4.8 km] SE Carrington Falls, 4.xii.1961 (NSW); *A.A.Hamilton NSW123985,* Medlow Bath, Leura, xi.1914 (NSW); *A.A.Hamilton NSW123986A*, Wentworth Falls, i.1915 (NSW); *A.M.Lyne 779 & J.Lyne*, c. 1 km NE Corang Pk, 11.vii.1992 (AD); *J.M.Maiden NSW123929*, Box Pt to Kangaroo River, x.1893 (NSW); *L.McDougall 26 & J.Steer*, junction of fire road 1 & 1E, Avon Dam, 9.xii.1986 (NSW); *C.Moore MEL92455* & *MEL92521*, Blue Mts, s.dat. (MEL); *M.E.Phillips CBG12691*, Jervis Bay, 18.x.1961 (CANB); *J.Pulley & I.R.Telford CBG52056*, The Castle, 17.vi.1971 (CANB); *F.A.Rodway 3181*, Sassafras Falls, 27.xi.1932 (NSW); *R.J.Rudd 153*, Jervis Bay, 20 m NE front gate of Australian National Botanic Gardens Annexe, 18.x.1991 (CANB); *D.W.Shoobridge CBG13105*, 23 mls [36.8 km] from Nerriga, 28.x.1962 (CANB); *D.W.Shoobridge CBG13817*, near Sussex Inlet, 24.ix.1964 (CANB); *J.Sturgess NSW 123969*, The Castle, iv.1944 (NSW); *I.R.Telford 9597*, Ettrema Gorge, 13.xi.1983 (CANB); *I.R.Telford 9609*, Monolith Valley, xii.1983 (CANB).

*Putative parents from the area*

***K. capitata* subsp. *capitata.*** New South Wales: *M.P. Austen 202*, c. 10 km SSE Sassafras, 28.vi.1973 (CANB); *M.P.Austen 204*, c. 11 km SSE Sassafras, 28.vi.1973 (CANB); *M.Evans 2718*, Carrington Falls, 16.xi.1967 (AD, CANB); *A.A.Hamilton NSW123987*, Lawson, i.1915 (NSW) (with some hairs on hypanthium and calyx); *T.G.Hartley 14314*, near Mt Tianjara, 25.iii.1975 (CANB); *I.Olsen 2873*, N Budawang Ra., 1.xi.1975 (NSW); *F.A.Rodway NSW123964*, Pacific City, 3.ix.1930 (NSW); *F.A.Rodway 14608*, Sassafras, 30 mls [48 km] SW Nowra, 9.ix.1947 (NSW); *F.A.Rodway NSW123967*, West Cambewarra Rd, 22.viii.1931 (NSW); *D.W.Shoobridge*

*CBG13596*, Sussex Inlet Rd, 24.ix.1964 (CANB); *I.R.Telford 3645*, Carrington Falls, 12.xi.1973 (CANB); *T. & J.Whaite 2948*, 10 mls [16 km] S Sassafras, 23.x.1965 (NSW).

***K. capitata* subsp. *seminuda.*** New South Wales: *B.G. Briggs NSW123970*, 3 mls [4.8 km] W Sassafras, 25. xii.1961 (NSW); *C.Dunlop 190*, Tianjara Falls, 9.xi.1968 (CANB); *E.Gauba CBG7228*, Jervis Bay, 14.vii.1950 (CANB); *E.Gauba CBG7231*, Pigeon Hose Ra., 16.xi.1951 (CANB, NE); *Gordon NSW123999B*, Barren Grounds, xi.1961 (NSW); *A.A.Hamilton NSW123986B*, Wentworth Falls, i.1915 (NSW); *A.H.Lyne 378 et al.*, Beecroft Penin., 27.viii.1991 (CANB); *A.H.Lyne 779 & J.Lyne*, above Corang Arch, c. 1 km NE Corang Pk, 11.vii.1992 (CANB); *I.Olsen 1971*, 2 mls [3.2 km] S Sassafras, 24.iii.1974 (NSW); *I.Olsen 2787*, near Ettrema Ck, 8.viii.1976 (NSW); *J.Pickard 1705*, 12.9 km ESE Nerriga, 6.ix.1971 (NSW); *F.A.Rodway 12382*, Tomerong, 30.x.1941 (NSW).

**(iii) *K. capitata* subsp. *capitata* × *K. rupestris***

The pale pink flowers and trilocular ovary of the hybrid are similar to *K. capitata*, but the plants are spreading shrubs, have papillae based hairs on the leaf margins, linear bracteoles, and some short hairs on the upper surface of the ovary, which has few ovules (8–14) per locule, more reminiscent of *K. rupestris*.

*Specimens examined*

New South Wales: *G.Butler 1566*, 4.3 km N Canoelands turnoff, 8.xi.1989 (CANB); *A.E.Orme 178 & R.D.Coveny*, c. 0.9 km along Paulls Rd from Windsor, 27.x.2001 (NSW); *P.G. Wilson 134 & B.J.Conn*, 2 km S South Maroota, 22.ix.1987 (AD, K, NSW).

*Putative parents from associated area*

***K. capitata* subsp. *capitata.*** New South Wales: *P.G.Wilson 133 & B.J.Conn*, 2 km S South Maroota, 22.ix.1987 (AD, K, NSW).

***K. rupestris.*** New South Wales: *G.Butler 1573 & A.M. Lyne*, 4.3 km N Canoelands turnoff, 8.xi.1989 (CANB); *P.G. Wilson 132 & B.J.Conn*, 2 km S South Maroota, 22.ix.1987 (CANB, K, NSW).

**33b. *Kunzea capitata* subsp. *seminuda* Toelken, *subsp. nov.***

*A subspecie typica foliis plicatis lobisque calycis et hypanthiis discretis glabris; a* K. similis *lobis calycis et hypanthiis discretis glabris ovariisque trilocularibus quoque 8–10 ovulis differt.*

**Type:** New South Wales, Wishing Well, Morton National Park, *H.R.Toelken 9558*, 27.x.2011 (holo.: AD; iso.: NSW).

*Kunzea capitata* auct. non (Sm.) Rchb. ex Heynh: Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991), pro parte.

Erect shrub to 1.5 m tall, often spindly with one or few stems. *Leaves* oblanceolate rarely linear-oblanceolate, (3.8–) 5–7 (–7.8) × (1.6–) 1.8–2 (–3.5) mm, folded lengthwise and with ± recurved upper third, with scarcely visible 3 (–5) veins, above and below glabrous or rarely with few spreading hairs below but wearing off soon, often with marginal cilia usually without basal tubercles. *Calyx lobes* acuminate and about twice longer than broad, glabrous as also the free hypanthium (rarely with scattered hairs); ovary with crisped or straight hairs up to 1 mm long. *Flowering*: October, November. **Fig. 10.**

*Distribution and ecology*. Usually associated with sandstone outcrops and often growing on shallow soil on rock platforms; recorded from open areas in woodland to forest, or in heath-like scrub on the Central and Southern Tablelands of New South Wales (CT, ST).

*Conservation status*. Widespread but rarely common in several conserved areas, such as Blue Mountains and Morton National Parks.

*Diagnostic features*. The spreading folded spathulate leaves of subsp. *seminuda* are similar to those of *K. obovata*, but the latter species is distinguished by its hirsute hypanthium and calyx lobes, the pubescent to puberulous upper surface of the ovary with the free hypanthium and the broader bracts, while the bracteoles are narrower and almost stalked. *K. parvifolia* has also similar features but is in all respects smaller, the leaves are up to 3.2 mm long and their double apex is not obviously recurved. The epithet of the Western Australian *K. similis* was adopted by Toelken (1996) and Toelken & Craig (2007) in observing its close resemblance to *K. capitata*, especially subsp. *seminuda*, as it also shares with it a single central vein of the leaves. The subspecies is, however, distinguished by glabrous calyx lobes and free hypanthium, as well as 8–10 ovules per locule.

*Variation*. The subsp. *seminuda* exhibits little variation in the Blue Mountains and, although leaves are usually narrower than those of the subsp. *capitata*, in one specimen from the upper Lachlan River (*A.Dulhunty MEL92768*) they are up to 3.5 mm broad. Similarly, a few plants were examined with some hairs on their abaxial leaf surfaces, particularly those below the inflorescence (*C.Burgess CBG33393*, Wentworth Falls; *C.Burgess CBG32449*, Kings Tableland). In the case of *C.Burgess CBG36186*, also from Kings Tableland, even the free hypanthium and the calyx are covered with few shorter hairs although the plant otherwise agrees in all other characters with *K. capitata* subsp. *seminuda*.

Two collections, *A.A.Hamilton NSW123986* (Wentworth Falls) and especially *A.A.Hamilton NSW123987* (Lawson), each contains two different elements, one of which is not only very hairy but also shows close resemblance to subsp. *capitata* and the other exhibits an intermediate mixture of characters of the two subspecies. Since the two specimens of each collection were probably collected in close proximity of one another they seem to indicate a few hybrids in that area, but no specimens of typical subsp. *capitata* have been seen from the Blue Mountains

Only few specimens of typical subsp. *seminuda* were examined from the Southern Tableland and South Coast regions, while most of the specimens known from that area exhibit varying numbers of characters of, or are

identifiable as subsp. *capitata*, as the two subspecies often occur in adjoining areas. For instance, only the latter subspecies occurs on deep sandy soils on dunes in the vicinity of Currarong, Ulladulla, south of Beecroft Peninsula, where usually subsp. *seminuda* and putative hybrids prevail. In addition the river valleys of the Shoalhaven and the Clyde River seem to have provided a congenial environment for the coastal subsp. *capitata* and with it introgressional forms between the two subspecies to extend their distribution inland, as the following well collected example localities indicate. Detailed population studies in the area are needed to evaluate the full extendt of hybridization.

*Note*. The subsp. *seminuda* is not synonymous with the var. *glabrescens* Bentham (1867), although both were characterised by a similar glabrescent or glabrous calyx among other characters. They are based on different populations and different types.

*Etymology*. As the free hypanthium and calyx lobes are glabrous and only the lower half of the hypanthium is covered with long spreading hairs the epithet "seminuda", Latin, "half-naked" seemed fitting.

*Specimens examined.*

More specimens from ST and SC are also cited under hybrids: *C. capitata* subsp. *capitata* × subsp. *seminuda*, in order to show the range of hybridization in those areas.

New South Wales: *W.F.Blakely NSW123992*, Wentworth Falls, 12.xi.1938 (NSW); *J.W.Boorman NSW123994*, Lithgow Water Works, i.1914 (NSW); *C.Burgess CBG32449*, Kings Tableland, 19.xi.1969 (CANB); C.*Burgess CBG33393*, Wentworth Falls, 19.xi.1969 (AD); *C.Burgess CBG36186*, Kings Tableland, 19.xi.1970 (BRI, CANB); *R.H.Cambage NSW123990*, Leura, xii.1906 (NSW); *J.H.Camfield NSW 123989*, Katoomba, xi.1908 (NSW); *L.Carne NSW123996*, Lawson, xi.1908 (NSW); *R.H.Goode 535*, near Sublime Pt, Leura, 4.xii.1961 (NSW); *J.Gregson NSW123991*, Mt Wilson, xi.1896 (NSW); *J.Gregson NSW123995*, Mt Tomah, i.1898 (NSW); *A.A.Hamilton NSW123984*, Mt Victoria, i.1915 (NSW); *V.Scarth-Johnson 135*, near Bell, xii.1969 (NSW); *M.J.Taylor 306 & R.G.Coveny*, near start of Golden Stairs Track, Katoomba, 23.x.1984 (AD).

*Putative hybrids*

**(i) *K. ambigua* × *K. capitata* subsp. *seminuda*:** see 48. *K. ambigua*

**(ii) *K. cambagei* × *K. capitata* subsp. *seminuda*:** see 32. *K. cambagei*

**(iii) *K. capitata* subsp. *capitata* × *K. capitata* subsp. *seminuda*:** see 33a. *K. capitata* subsp. *capitata*

**(iv) *K. capitata* subsp. *seminuda* × *K. parvifolia***

The following examples from New South Wales are here evaluated individually, as they differ slightly, possibly because of local variation, although they exhibit characteristics of both putative parents.

CT: One of the below listed Constable collection "B" has much smaller leaves, short and broad calyx lobes and the whole plant, including the hypanthium and calyx lobes, is covered with short more or less appressed hairs, as they are found in *K. parvifolia*. Furthermore the few flowers in each inflorescence are characteristically directed upwards. However, the characteristic double-apex of leaves of *K. parvifolia* was not observed, so that this specimen, though very similar to *K. parvifolia*, is assumed to be a hybrid *K. capitata* subsp. *seminuda* as represented by Constable specimen "A".

ST: The hybrid (*B.G.Briggs & D.F.Blaxell 85*) is not only recognised by white flowers, but the whole plant has short spreading hairs particularly on and below the inflorescence, it has smaller leaves and few-flowered inflorescences similar to *K. parvifolia*. The specimen does not show the characteristic double-apex of leaves, typical of *K. parvifolia*, and is therefore interpreted as a hybrid. The other pale-pink-flowered specimen from the same locality (*B.G.Briggs & D.F.Blaxell 84*) is closest to the subsp. *seminuda* in all its characters, including the absence of marginal tubercles of the leaves. The third, more robust specimen from the area (*B.G.Briggs & D.F.Blaxell 83*), has the typical marginal tubercles and exhibits at least three clear longitudinal veins, indicating that it forms part of the introgressional population associated with *K. capitata* subsp. *capitata* × subsp. *seminuda*, which is widespread in the area. It is therefore possible that this population includes triple-hybrids.

*Specimen examined*

New South Wales: *B.G.Briggs & D.F.Blaxell 84A*, 1 mile [1.6 km] S Sassafras, 6.xii.1968 (NSW); *E.F.Constable B*, Blackheath, 26.xi.1946 (NSW); *A.A.Hamilton NSW123988*, Medlow Bath, xi.1914 (NSW); *H.R.Toelken 6860*, c. 35 km WSW Nowra airport to Nerriga, 30.x.1986 (AD) (flower buds immature); *H.R.Toelken 6878,* 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD).

*Putative parents from the area*

***K. capitata subsp. seminuda.*** New South Wales: *B.G. Briggs & D.F.Blaxell 84B*, 1 mile [1.6 km] S Sassafras, 6.xii. 1968 (NSW); *E.F.Constable A*, Blackheath, 26.xi.1946 (NSW); *H.R.Toelken 6859*, c. 35 km WSW Nowra airport to Nerrigo, 30.x.1986 (AD) (flower buds immature); *H.R.Toelken 6884,* 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD).

***K. parvifolia.*** New South Wales: *W.Forsyth & A.A. Hamiton NSW124084*, Badgerys Crossing to Nowra, ix.1899 (NSW); *R.Pullen 2223*, Bulee Ridge, 25.ix.1960 (NSW); *R.Story 7878*, 15 mls [24.km] NNE Braidwood, 13.4.1967 (NSW); *H.R.Toelken 6858*, c. 35 km WSW Nowra airport to Nerriga, 30.x.1986 (AD) (flower buds immature); *H.R.Toelken 6880,* 13.4 km Nerriga to Sassafras, 11.xi.1986 (AD); *W.Underwood NSW124094*, between Turpentine and Sassafras, xi.1936 (NSW).

### 34. *Kunzea obovata* Byrnes

Austrobaileya 1: 469 (1982); T.D.Stanley in T.D.Stanley & E.M.Ross (eds), Fl. S.E. Queensland 2: 133 (1986); Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); A.R.Bean in R.J.F.Henderson (ed.), Queensland Pl. 133 (1997). — **Type:** Queensland, Cottonvale-Amiens road, *Byrnes 3932* (holo.: BRI247872; iso.: CANB378161, K000843051, L9495, NSW639626, PERTH1636626).

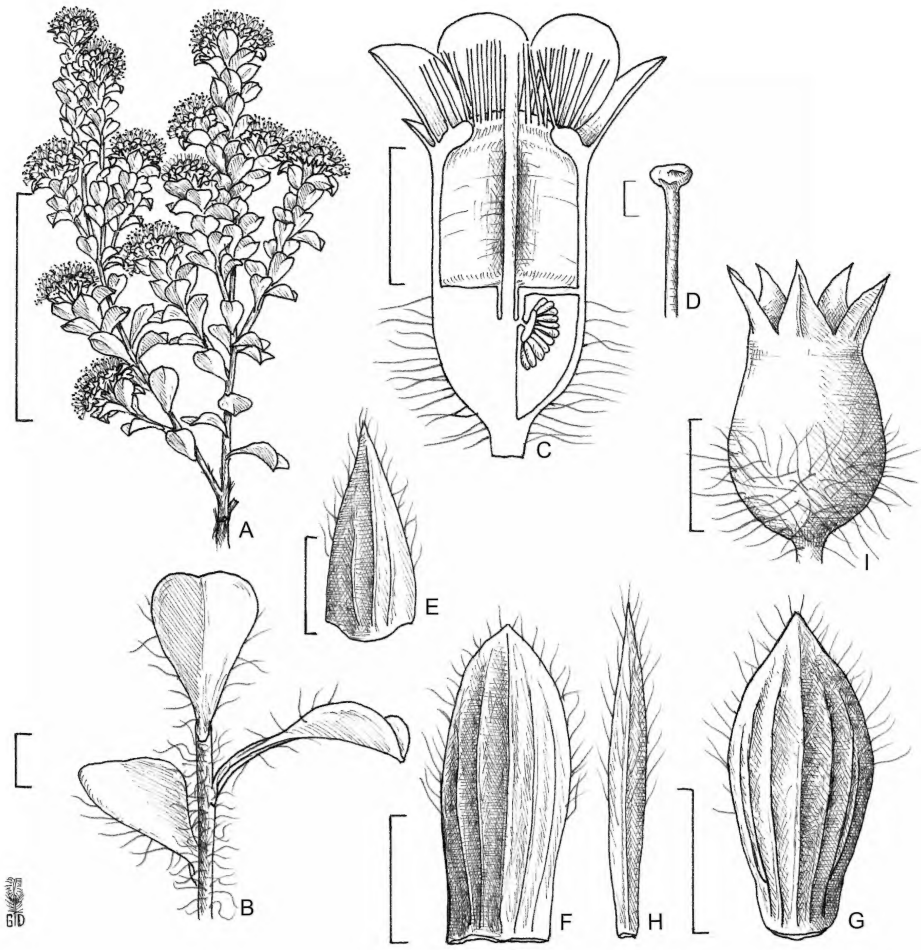


**Fig. 10.** ***K. capitata*** **subsp.** ***seminuda***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** capitate stigma; **E** abaxial view of perule; **F** abaxial view of proximal bract; **G** abaxial view of distal bract; **H** abaxial view of bracteole; **I** fruit. — Scale bars: **A** 4 cm; **B** 1 mm; **C** 2.5 mm; **D** 1.5 mm; **E** 1.5 mm; **F–H** 2 mm; **I** 2.5 mm. — **A–H** *H.R.Toelken 6867* (AD); **I** *A.A.Hamilton NSW123984*.

Shrubs (0.5–) 1.5–2.5 (–3) m tall, with many spreading branches; young branches with leaf bases slightly raised but not flanged, hirsute, pilose, rarely pubescent, with ± spreading long hairs over fewer shorter ones; early bark splitting mainly longitudinally, peeling in slender membranous pieces with irregular to straight margins. *Leaves* alternate; *petiole* (0.3–) 0.6–1 mm long, usually appressed; *lamina* oblanceolate to linear-oblanceolate, rarely oblong-elliptic, (1.8–) 3–8 (–9.6) × (0.6–) 1.2–1.5 (–1.8) mm, ± abruptly constricted into a recurved acute apex, gradually tapering into petiole, above folded lengthwise and concave, especially towards the apex, ± convex and often with raised main vein below, sparsely hirsute usually glabrescent but with shorter hairs above, hairs spreading to appressed, with marginal cilia each with a broad persistent tubercle. *Inflorescence* a rounded botryum, often with clusters of spreading leaves below, with (4–) 6–18 (–25) flowers, apparently terminal on all branches, with vegetative growth after fruiting often continuing not terminally; *retained perules* (0–) 3–8, narrow-triangular rarely ovate or oblong-ovate, 1.2–1.9 mm long, with 1 (–3) veins, with spreading hairs, especially upper ones often caducous; *bracts* ovate, oblong-ovate, rarely oblong-lanceolate or oblong-obovate, (2.2–) 2.5–3.5 (–4.2) × (1.2–) 1.6–2 (–2.5) mm, usually rostrate, with (1–) 3 veins, pilose; *bracteoles* in pairs, linear-oblanceolate to -elliptic, sometimes falcate, 1.3–1.8 × 0.3–0.8 (–1.2) mm, with central main vein, pilose. *Hypanthium* 2–2.8 (–3.1) mm long when flowering (free tube 0.9–1.6

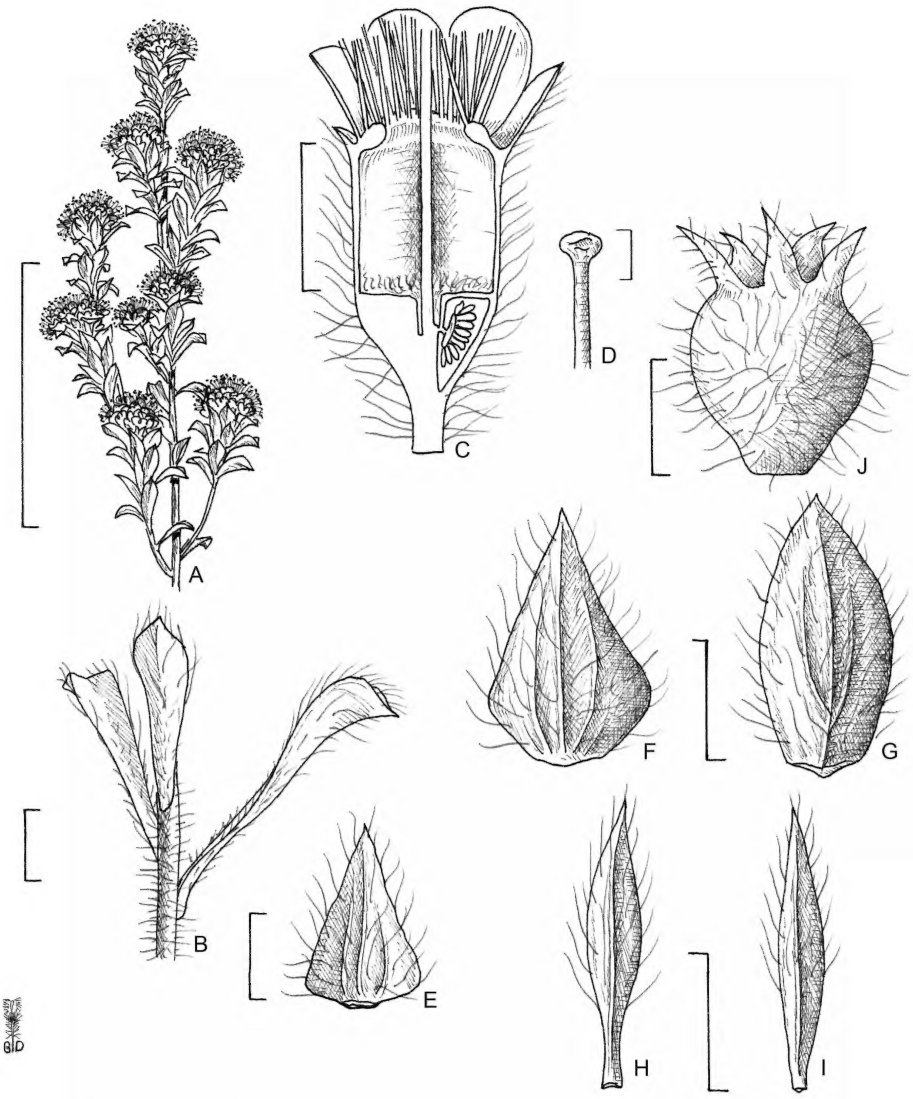


**Fig 11.** ***K. obovata***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** capitate stigma; **E** abaxial view of perule; **F** abaxial view of proximal bract; **G** abaxial view of distal bract; **H** abaxial view of proximal bracteole; **I** abaxial view of distal bracteole; **J** fruit. — Scale bars: **A** 4 cm; **B, F, G** 1 mm; **C, H, I, J** 1.5 mm; **D, E** 0.5 mm. — **A–I** *K.A.W.Williams 75106* (BRI); **J** *R.W.Jessup & M.Gray 79* (BRI).

mm), pilose to hirsute, with spreading hairs 0.3–0.6 mm long. *Calyx lobes* usually narrow-triangular, 1.4–1.8 mm long, pointed and ridged towards the apex, pilose to sparsely so. *Corolla lobes* obovate rarely orbicular and shortly clawed, 1.5–2.2 mm long, ± erose, deep-purplish to rarely pink. *Stamens* 37–50 in more than one whorl; *filaments* 2.8–4.7 mm long; *anthers* broadly ellipsoidal, 4.5–6 mm long, with red subterminal gland. *Ovary* 3-locular, with style somewhat sunk into the hairy upper surface; *placenta* a broad-elliptic disc with short central attachment, scarcely bilobed, with each lobe with usually 2 rows of ovules; *ovules* 25–45 per locule, spreading, subequal; *style* 3.8–5.6 mm long, with stigma small-capitate, scarcely compressed at the apex. *Fruit* an urceolate capsule with erect calyx lobes. *Seeds* (immature) angular-cylindrical with blunt ends, often somewhat crescent-shaped, with testa brown and with dense vertical ribbing, rarely confluent. *Flowering*: September–November (December). **Fig. 11.**

*Distribution and ecology*. Grows in sandy soils usually associated with granite boulders in dry sclerophyll forest or shallow skeletal soil on granite in southern Queensland (DD, MO) and northern New South Wales (NT, NC).

*Conservation status*. Locally common and conserved in several parks, for instance, Girraween and Boonoo Boonoo National Park.

*Diagnostic features*. Although very similar to *K. parvifolia*, the obovate to usually oblanceolate leaves of *K. obovata* have, in contrast to that species, a distinctly recurved apex, and the hypanthium and calyx lobes are pilose with spreading hairs 0.3–0.6 mm long, while in *K. parvifolia* they are very short and ± appressed, if at all present. Similar short appressed hairs are also typical of *K. badjaensis*, another species resembling *K. obovata*, but it has a more or less decumbent habit.

*Variation*. The leaves are oblanceolate, linear-oblanceolate or rarely obovate as the specific epithet indicates. However, some lower leaves, and especially those subtending lateral branches off long shoots, often become broader to oblong-elliptic and with scarcely recurved apex. These characteristics, as well as the long spreading hairs on the hypanthium and calyx lobes, are found throughout the species, even in all plants examined from between Torrington and Emmaville, which are usually smaller in all respects so that they are often interpreted as intermediates between *K. obovata* and *K. parvifolia*. No real intermediates have as yet been recorded from this area, and only one individual has been found near Howell (see also *K. parvifolia*, variation 3), which is possibly a hybrid.

Throughout the range of the species the density of the indumentum varies much, as in *K. parvifolia*, but unlike that species the hairs are always more or less spreading.

Although terminal vegetative growth from the apex of the infructescence is usually found in this species, some specimens, e.g. *R.G.Coveney 16568 & A.J.Whalen* (AD), show a "pseudodichotomy" particularly of lateral branches due to branching from below the previous season's inflorescence. In this particular specimen (probably a senescent plant) this unusual lateral growth is repeated several times on lateral branches while terminal growth is prevalent on terminal actively growing branches.

*Selection of specimens examined (44 seen)*

Queensland: *A.R.Bean 6364 & P.I.Forster*, Bald Rock Ck, 4.ix.1993 (NSW); *T.J.Bowen BRI274347*, Bapaume-Pozieres road, 30.x.1956 (BRI); *N.B.Byrnes 3928*, Cottonvale to Amiens, 9.x.1979 (BRI, NSW); *M.S.Clemens BRI274346*, near Ballandean, x.1944 (BRI); *S.L.Everist 8121*, near Passchendaele, 16 km N Stanthorpe, 13.x.1968 (BRI, NSW); *M.T.Mathieson 470*, Passchendaele S.F., via Goldfields Rd, 5.ix.2009 (BRI); *L.Pedley 1465*, Fletcher, 8 mls [12.8 km] SW Stanthorpe, 29.x.1963 (BRI); *J.Staer NSW147309*, Wallangarra, x.1911 (NSW); *I.R.Telford 3191*, Bald Rock Ck, 10 mls [16 km] N Wallangarra, 26.ix.1973 (A, CANB, L, K); *I.R.Telford 12354 & S.Donaldson*, summit plateau of Mt Maroon, 19.viii.1996 (CANB); *K.A.W. Williams 75106*, 6 km W Thulimbah, 7.x.1975 (BRI).

New South Wales: *A.R.Bean 6581*, 30.6 km Ashford to Emmaville, 22.ix.1993 (NSW); *J.L.Boorman NSW124107*, Barren Mtn, Deer Vale, xi.1913 (NSW); *J.L.Boorman NSW124108*, Emmaville, x.1901 (NSW); *R.G.Coveny 2250*, 5 mls [8 km] N Deepwater on New England Hwy, 3.x.1969 (BRI, NSW); *R.G.Coveny 16568 & A.J.Whalen*, 0.6 km from Boonoo Boonoo Falls, 14.x.1993 (AD; BRI, CANB, HO, K, L, MO, n.v.); *P.Gilmour 7818*, Carrai Ck, W Kempsey, 11.ix.1997 (NSW); *G.J.Harden & D.W.Harden s.n.*, Torrington, x.1992 (AD, NSW); *J.T.Hunter 3419*, Flagg Ra., N Bendemeer, 5.viii.1995 (NSW); *R.Johnstone 2169 & A.E. Orme*, c. 15.5 km Emmaville to Ashford, 7.xi.2007 (NSW); *M.E.Phillips CBG18145*, 3 mls [4.8 km] Torrington to Tent Hill, 19.ix.1966 (CANB); *J.B.Williams NE37011*, c. 16 km WSW Dorrigo, xii.1967 (NE); *J.B.Williams NE37015*, Bolivia Ra., 19.xi.1966 (NE); *J.B.Williams & H.J.Wissmann NE37014*, near Mt Slow, SE Glen Innes, 21.x.1966 (NE); *H.J.Wissmann NE31170*, 55 km E Armidale, ix.1974 (NE); *H.J.Wissmann NE37012*, c. 9.6 km E Baldersleigh, 12.xii.1967 (NE).

*Putative hybrids*

**(i) *K. bracteolata* × *K. obovata*:** see 41. *K. bracteolata*.

**(ii) *K. obovata* × *K. parvifolia***

This specimen consists of three separate branchlets all with acute leaves with no obvious double apex. The length of the hairs on the hypanthium, although somewhat immature, fall on the two left-hand branchlets into the range of *K. obovata*, while they are much shorter on the right-hand branchlet. The leaves are, however, oblong-elliptic to -lanceolate and with ± appressed hairs which is reminisent to those of *K. parvifolia*.

This only specimen with somewhat intermediate characters is highlighted here to draw attention to it, although there is no evidence for hybridisation and this could be an odd variant (cf. *L. Wheeler 121* in variations 3, *K. parvifolia*), particularly as *K. obovata* has not been recorded so far west.

*Specimen examined*

New South Wales: *J.B.Williams NE37029*, 3 mls [4.8 km] Howell to Copeton, 6.ix.1966 (NE).

*Putative parents from the area*

***K. obovata.*** New South Wales: *R.Johnstone 2169 & A.E. Orme*, c. 15.5 km Emmaville to Ashford, 7.xi.2007 (NSW); *J.B.Williams & H.J.Wissmann NE37014*, near Mt Slow, SE Glen Innes, 21.x.1966 (NE).

***K. parvifolia.*** New South Wales: *J.B.Williams NE37024*, 3 km Howell to Copeton, 20.ii.1966 (NE); *J.B.Williams NSW124101*, 2 mls [3.2 km] E Howell to Tingha, 22.i.1967 (NSW).

**(iii) *K. obovata* × *K. opposita* var. *opposita***

Bracts are ovate to oblong-ovate, all leaves are more or less flat or often folded lengthwise and at least upper short leaves have recurved apices as observed in depauperate specimens of *K. obovata*, e.g. *L.W.Jessup & M.Gray BRI274349* with all leaves oblanceolate and older ones usually even more recurved. But the lower

leaves are elliptic to oblong-lanceolate and more or less appressed, more like *K. opposita*.

Since only a single branch of this putative hybrid was found in among a number of typical specimens of *K. obovata* in the population collection *McKie 216*, among granite boulders at Backwater, hybrids forming between these two species seem highly likely.

*Specimens examined*

New South Wales: *E.N.McKie 216B*, Backwater, 3.xi. 1930 (NSW).

*Putative parents from the area*

***K. obovata.*** New South Wales: *E.N.McKie 216A*, Backwater, 3.xi.1930 (NSW); *I.R.Telford 1405*, Pheasant Mt., NE of Backwater, 1.ix.1969 (CANB).

***K. opposita* var. *opposita.*** New South Wales: *E.N. McKie BRI1274327*, Guyra, s. dat. (BRI).

### 35. *Kunzea parvifolia* Schauer in Lehm.

Pl. Preiss. 1: 124 (1844); Benth., Fl. Austral. 3: 115 (1867); Ewart, Fl. Victoria 865 (1931); N.C.W.Beadle et al., Handb. Vasc. Pl. Sydney District 290 (1963); Cockrane et al., Fl. & Pl. Victoria, t. 207 (1968); N.T.Burb., Fl. Austral. Cap. Terr. 267, fig. 266 (1970); J.H.Willis, Handb. Pl. Victoria 2: 450 (1973); N.C.W.Beadle, Student Fl. N.E. New South Wales 3: 477 (1976); N.C.W.Beadle et al., Fl. Sydney Region, ed. 3, 344 (1988); Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); Carolin & Tindale, Fl. Sydney Region, ed. 4, 396 (1993); Jeanes in N.G.Walsh & Entwisle (eds), Fl. Victoria 3: 1020 (1996); Pellow et al., Fl. Sydney Region, ed. 5, 202 (2009). — *K. parvifolia* var. *parvifolia* Maiden & Betche, Proc. Linn. Soc. New South Wales 38: 246 (1913). — **Type:** New South Wales, Argyle, *K.K.A von Hügel s.n.* (lecto., designated here: W).

*Kunzea parvifolia* var. *alba* Maiden & Betche, Proc. Linn. Soc. New South Wales 38: 246 (1913); Census N.S.W. Pl. 153 (1916). — **Type:** New South Wales, Rockley, *J.L.Boorman s.n.*, xi.1906 (lecto., designated here: NSW124073). **Remaining syn.:** near Braidwood, *R.H. Cambage s.n.*, xi.1908 (NSW, n.v.).

Shrubs 0.5–1.2 (–2) m tall, with many spreading branches; young branches with leaf bases somewhat raised but not flanged, ± densely pubescent with mainly long hairs appressed to slightly spreading; early bark scarcely fluted, peeling in membranous slender pieces or strips with irregular margins. *Leaves* alternate to subopposite; *petioles* 0.2–0.4 (–0.6) mm, appressed; *lamina* narrow-elliptic to linear-oblanceolate, rarely linear-lanceolate, (0.8–) 1.5–3.2 (–3.4) × (0.6–) 0.8–1 (–1.3) mm, obtuse to truncate, rarely acute becoming obtuse, ± abruptly constricted into a recurved apex terminating usually in an apparent subterminal abaxial point (double-pointed apex), ± gradually tapering into petiole, concave to shallow-canaliculate above, convex and often with ridged main vein below; puberulous to pubescent or glabrescent with appressed hairs, or appressed when young to often somewhat spreading later. *Inflorescence* a rounded botryum but flowers often erect with leaves below ± appressed at the base, with (1–) 3–8 (–11) flowers, apparently terminal on long shoots and especially common on short shoots, with terminal vegetative growth continuing after fruiting; *retained perules* 0–4, ovate rarely oblong-ovate, with 1–3 veins, ± hairy; *bracts* ovate, oblong-elliptic to oblong-obovate, (1.5–) 2.5–3.5 × 0.8–1.5 mm, cuspidate rarely acuminate, with 3–5-veins, with few to many, appressed to spreading hairs; *bracteoles* in pairs, ovate on lower flowers to sometimes linear-lanceolate and ± falcate on upper one, (0.8–) 1.5–2.6 (–3) × 0.4–1.2 mm, with one central vein, usually appressed-pubescent and ± ciliolate. *Hypanthium* 1.6–2.6 mm long when flowering (free tube 0.7–1.5 mm long), glabrous or glabrescent with appressed hairs rarely with slightly spreading hairs up to 0.3 mm long. *Calyx lobes* triangular-ovate, 0.7–1 mm long, acute to pointed (often double-pointed), glabrous or with short hairs. *Corolla lobes* obovate-orbicular, scarcely clawed, 1.3–1.8 (–2.2) mm long, ± erose, pink to mauve or rarely white. *Stamens* 33–38 in more than one whorl; *filaments* 2.1–3.4 mm long; *anthers* broadly ellipsoidal, 0.28–0.35 mm long with red subterminal gland. *Ovary* 3-locular, with style not or scarcely sunk into the usually ± hairy upper surface; *placenta* a broad-elliptic disc with short central attachment, scarcely bilobed with each lobe with usually 2 rows of ovules; *ovules* (12–) 20–30 (–35) per locule, spreading, subequal; *style* 2.5–3.5 mm long, with stigma small-capitate, scarcely compressed at the apex. *Fruit* an urceolate capsule with erect calyx lobes. *Seeds* obloid-ellipsoidal, 0.6–0.7 mm long, with ± blunt ends and coarse vertical ridges. *Flowering*: (September–) October–November (–January). *Common name*: **Crimson kunzea** (Ewart 1931); **violet kunzea** (Willis 1973, Jeanes 1996). **Fig. 12.**

*Distribution and ecology*. Grows often on seepage areas or sometimes on shallow acid soil mainly on granite or sandstone shelves in heath, or open patches usually in dry sclerophyll forest or often common in deforested areas; found in New South Wales (CC, SC, NT, CT, ST, NWS, CWS, SWS) and Victoria (GR, MID, EHL, SNOW, EG).

*Conservation status*. Locally common and known from several conserved areas, e.g. Morton National Park, Grampians National Park.

*Diagnostic features*. Although some forms of *K. parvifolia* are very similar to *K. obovata* (cf. variation, below) it can be identified by one or more of the following characteristics:

The usually linear leaves of *K. parvifolia* are commonly up to 3.2 mm, or rarely up to 4 mm long, but the apex does not usually appear obviously recurved, because a distal abaxial ridge continues in line with the central vein to form an abaxial subterminal appendage or double-pointed apex of the leaves (cf. fig. 12B), which is usually visible in young leaves and particularly on leaves below the inflorescences. The leaves are often more or less appressed to the branches and clasping the base of the inflorescence, but in cultivated plants

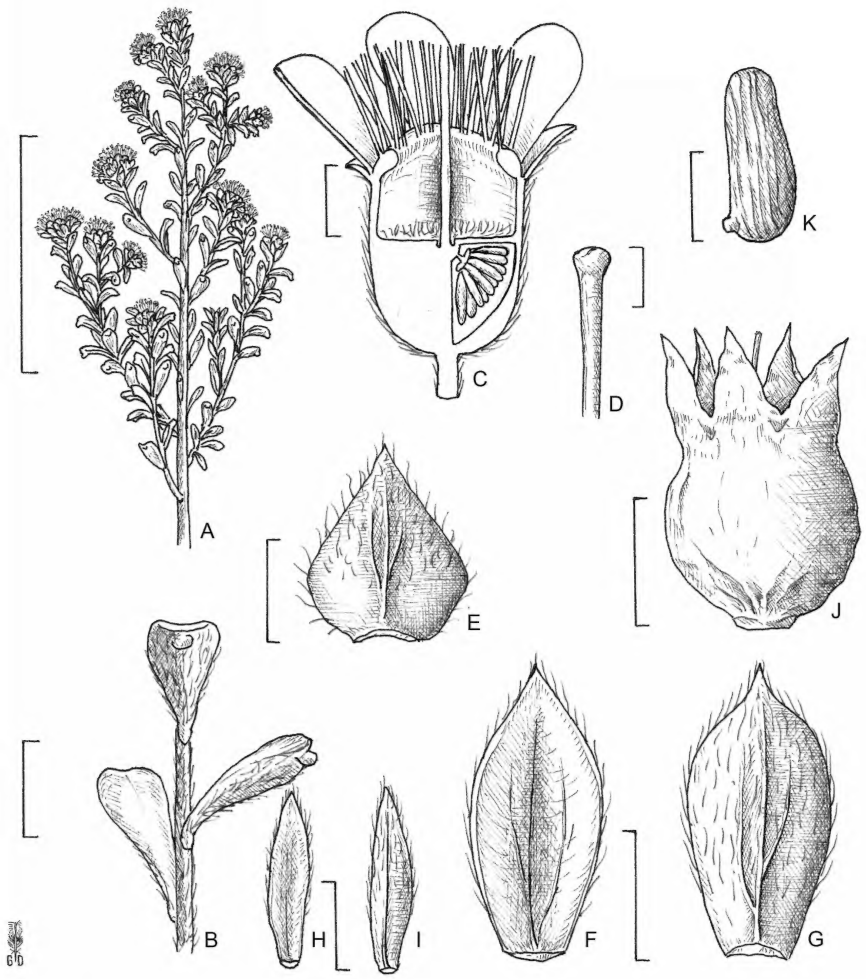


**Fig. 12.** ***K. parvifolia***: **A** flowering branch; **B** cauline leaves showing subterminal abaxial appendage; **C** half flower; **D** capitate stigma; **E** abaxial view of perule; **F** adaxial view of bract; **G** abaxial view of bract; **H** adaxial view of bracteole; **I** abaxial view of bracteole; **J** fruit; **K** seed. — Scale bars: **A** 5 cm; **B, C, F–I** 1 mm; **D, E** 0.5 mm; **J** 1.5 mm; **K** 0.25 mm. — **A–I** *H.R.Toelken 6845* (AD); **J, K** *A.K.Fitzhenry* (NSW).

they are usually spreading and recurved even below the inflorescences, similar to those of *K. obovata*. The hypanthium and usually also the calyx lobes of *K. parvifolia* are glabrous, or glabrescent or, if with spreading hairs, then individual hairs are shorter than 0.3 mm long, in comparison to those of *K. obovata*, which are often longer than 1 mm.

*Variation*. The local variation and this widespread species must be studied in detail to understand delimitation accepted here. Throughout the range of the species the size of the bracts and bracteoles relative to the hypanthium may vary much between populations and within the same population. Also, the leaves show a large range of variation, but usually they are ± oblong and erect with a double apex (fig.12B). The leaves are often very different on fast growing juvenile plants than on older plants, which are distinguished by having an intricate branching system reminiscent to species of sect. *Floridae*, except that in *K. parvifolia* the distinction between long shoots and short shoots is not as well developed as in extreme cases in the *Floridae*, e.g. *K. preissiana*.

(1) Specimens (including the type) from the Central and Southern Tablelands and coasts of New South Wales as well as the adjoining parts of north-eastern Victoria differ from *K. obovata* in their short oblong leaves with subterminal appendage and leaves clasping the base of the inflorescence, and hypanthium and calyx lobes are usually glabrescent with short appressed hairs. The fre-

quent absence of hairs on the upper surface of the ovary from populations near Berrima and southwards into the Shoalhaven River valley is unusual. From this area several specimens with white petals have been recorded and described in the past as var. *alba*, but, as with white-flowered specimens from other species, this character could not be linked with other characters, so that this variety was reduced to synonomy. An exception was however made for some specimens from between Junee and Cootamandra, which show extreme local variation examined and are here referred to a hybrid swarm of *K. occidentatilis* × *K. parvifolia* (cf. *K. occidentalis*: hybrids).

(2) Some plants of *K. parvifolia* growing on the Tinderry Mountains do not have a well developed double apex of the leaves (e.g. *E.M. Canning 3327*), but the oblong-obovate leaves are dorsiventrally flattened, i.e. they cannot be confused with those of nearby *K. badjaensis*. The absence of the double-apex is often observed on the usually relatively small leaves of plants growing at high altitude.

(3) *K. parvifolia* occurs in a number of often isolated localities mainly on the western slopes of the Great Dividing Range from the Grampians in the south-west to near Inverell in the north-east. In contrast to the previous variant, the leaves are usually narrow-oblong and often ± densely covered with fine appressed hairs, which are often not fully appressed on young leaves. The leaves have usually a well developed subterminal appendage or double apex typical of the species, except in extreme northern parts between Howell and Inverell (cf. diagnostic features of *K. opposita* discussing possible introgression between the two species in that area). Although the leaves are often slightly oblanceolate in this northern area, their apices are rarely acute nor distinctly recurved. The dense, usually ± appressed tomentum of the leaves throughout most of this western range of the species stands in direct contrast to the glabrescent leaves with few spreading hairs in plants of *K. obovata* from nearby Emmaville to Torrington and further north. The long spreading hairs on the perules and bracts may be misleading, particularly on immature inflorescences, but all such specimens investigated had shorter hairs on the hypanthium and calyx, unlike those in *K. obovata*. The superficial resemblance of the form from south of Inverell to that of *K. obovata* north of Emmaville seem to be a parallel development rather than clonal, judging by these differences. Nor was a wide range of variation in either population found to indicate hybridization between these somewhat similar species. However, one specimen, *J.B.Williams NE37029*, 3 km Howell to Copeton, indicates that occasional intermediates/hybrids with *K. obovata* might occur, because it has oblong-elliptic leaves with many appressed hairs and an acute apex, and the hairs on the hypanthium are of intermediate length. In other places the two species were recorded apparently together without any intermediates as, for instance, at Black Ck, Guyra (*E.N. McKie NSW124110A: K. obovata*; *NSW124110B: K. parvifolia*). The distinction between the two species is further complicated by a putative hybrid *K. obovata* × *K. opposita* (cf. *K. obovata*: hybrids) from Backwater (*E.N.McKie 216*).

An odd specimen (*J.H.Willis MEL92608*, Pine Mt near Walwa), well away from the above distribution of *K. obovata*, has pointed leaves with the marginal ridge scarcely developed (no distinct double-apex) reminiscent to leaves of *K. obovata*. It is, however, accepted as *K. parvifolia*, as the leaves are oblong-elliptic to oblong-lanceolate with short ± appressed hairs, and with short spreading hairs on the hypanthium.

(4) The long spreading hairs on the whole plant and especially on the hypanthium and calyx of plants from Mt Buffalo (Victoria) are similar to those of *K. obovata*, except that the leaves are usually much smaller and flat, as well as the typical subterminal appendage is usually present, but, like in the case of plants from the Tinderry mountains, it is often not well developed. Although these plants have unusually short and broadly oblong-obovate leaves, they are more oblong at lower altitude, e.g. Eurobin Falls (*Robbins MEL524665*).

The variation shown by some pink-flowered specimens recorded from between Junee and Cootamundra (NSW) may be interpreted as hybrids between *K. occidentalis*, a plant rarely recorded from that area, and *K. parvifolia* (cf. putative hybrids of 47. *K. occidentalis*).

*Notes*. *Kunzea obovata*, like *K. badjaensis,* was once considered part of the variable *K. parvifolia*, and the present delimitation and characterisation of the latter species have been slightly emended (cf. *K. parvifolia*, variations).

*Typification*. The sheet of a Hügel collection in W, annotated in a similar handwriting as other species described by Schauer and agreeing with the protologue, is selected as lectotype of ***K. parvifolia***.

As the one syntype of ***K. parvifolia* var. *alba*** (*R.H. Cambage*, near Braidwood, xi.1908) could not be traced, the specimen *J.L.Boorman*, Rockley, xi.1906, which conforms with the protologue, has been selected as lectotype.

*Selection of specimens examined (308 seen)*

New South Wales: *R.H.Anderson NSW64412*, Tooma, 12 mls [19.2 km] S Tumbarumba, xi.1938 (MEL, NSW); *W.A.W.de Beuzeville NSW124080*, Bombay, Shoalhaven River, 16.ii.1932 (NSW); *P.Beesley 519 et al*., 27.5 km NNW Boorowa, 30.x.1985 (AD); *B.G.Briggs 914*, 2 mls [3.2 km] W Timor Rock, Warrumbungles, 24.x.1966 (NSW); *B.G.Briggs 1588*, near Tolwong, Nerriga, 28.1.1968 (NSW); *J.D.Briggs 2284*, 1 km S railway crossing at Alleena, 19.x.1987 (CANB); *R.H.Cambage 2113*, E Biddon Rd, Gilgandra, 15.x.1904 (NSW); *R.H.Cambage 2997*, Tharwa Rd, Queanbeyan, 6.xi.1911 (NSW); *E.M.Canning 3327*, 6.7 mls [10.7 km] from Michelago to Little Tinderry Hmsd, 7.xii. 1972 (CANB); *A.D.Chapman 1564*, Lees Pinch, 13 km NW Bylong, 2.x.1979 (AD); *R.J.Chinnock 7777 & J.Briggs*,

1 km S Alleena, 13.x.1987 (AD); *W.F.Clark NSW124113*, Boyd Ck, Kanangra district, xii.1966 (NSW); *L.Costermans NSW168924*, W Lithgow, xi.1973 (NSW); *R.Coveny 12391 et al.*, Limestone Ck, 6.7 km Moredun Rd from Tenterden to Tingha, 13.xii.1987 (AD); *L.A.Craven 645*, 4 mls [6.4 km] NE Nerriga, 13.x.1965 (MEL; B, BH, CHR, E, G, K, L, NSW, P, US, n.v.); *I.Crawford 6618*, 0.8 km S Lake Bethungra dam wall, 28.x.2001 (CANB); *A.Floyd 16*, near Inverell, 30.x.1956 (NSW); *W.Forsyth NSW124074*, Bombala Hill, i.1910 (NSW); *M.Gray 2354*, Gilgai, 8.xii.1953 (NE); *G.J. Harden NE38912*, Mt Naman, 20.viii.1975 (NE); *B.Kennedy NSW124096*, Trinkey S.F., 50 km SW Gunnedah, x.1977 (NSW); *P.Lindsay NSW124079*, Talbingo, 26.x.1978 (NSW); *J.H.Maiden NSW124083*, Barbers Ck, i.1898 (NSW); *E.N. McKie 2325*, Kings Gap, near Bundarra, 14.x.1940 (NSW); *H.S.McKie 11724*, Black Mtn, ACT, 8.xi.1964 (NSW); *B.J.Lepschi 6360 & A.N.Schmidt-Lebuhn*, c. 11.5 km SE Koorawatha, 11.xi.2010 (CANB); *Monagan NSW124093*, near Nowra Hill, ix.1945 (NSW); *A.Morris 2232*, between Gulgong & Dubbo, 5.viii.1928 (NSW); *I.Olsen 1938*, Uriarra Crossing, Swamp Ck, 27.ii.1974 (NSW); *M.Parris 9182 & N.Fisher*, Tingaringi Fire Trail, Kosciusko N.P., 15.ii.1987 (AD); *R.W.Purdie 6277*, Black Mtn Nature Res., 20.x.2006 (CANB); *R.W.Purdie 7035,* Ironmungy Nature Res., 30.xii. 2008 (CANB); *Ralph NSW124112*, Oberon, Wells Rd, s.dat. (NSW); *R.Schodde 3145*, Gibraltar Ck area, 14.xi.1962 (AD, MEL, NE, NSW); *D.W.Shoobridge CBG13564*, near Gilgandra, 3.x.1964 (AD); *C.Stafford NSW124103*, Merriwa, 1.xii.1945 (NSW); *J.B.Williams NE10395*, Dunley Vale, NW Guyra, x.1959 (NE); *J.B.Williams NE37024*, 3 km Howell to Copeton, 20.ii.1966 (NE); *J.B.Williams NE37028*, N Bundarra on road to Inverell, 22.i.1967 (NE); *J.B.Williams NSW124101*, 2 mls [3.2 km] E Howell to Tingha, 22.i.1967 (NSW); *P.G. Wilson 49 & J.Highet*, Goonoo S.F., Dubbo, 2.x.1983 (AD); *E.K.Winterhalder NE9524*, 51 km E Gilgandra, ix.1958 (NE); *C.A.Winters NSW124106*, Cootamundra to Bethungra Rd, 31.x.1951 (NSW).

Victoria: *J.Ackland 169*, 1 mile [1.6 km] N Bundarrah River crossing, 23.xi.1964 (MEL); *D.E.Albrecht 3593*, Wermatong track, c. 7 km NE Mt Burrowa, 22.x.1987 (AD, MEL); *A.C.Beauglehole 36857*, Mt Sister, 20.ii.1971 (MEL); *M.G.Corrick 5720*, Mt William Rd, Grampians, 20.xi.1976 (MEL); *H.M.Jolly 18 et al.*, 6.3 km W Whitfield, 13.x.1996 (NE, CANB); *R.A.Keble MEL92599*, Walwa, 15.x.1951 (MEL); *A.Meebold 21713*, Glenn Wiles, xii.1936 (NSW); *R.Melville 3034 & N.Wakefield,* Wulgulmerang, 21.i.1953 (MEL, NSW); *F.Mueller MEL92592*, Mt Buffalo Ra., 8.iii.1853 (MEL); *F.Mueller MEL92612*, Mt Hotham, 1893 (MEL); *A.E.Orchard 2772*, 4 km E Mt Seldom Seen, c. 10 km SW Wulgulmerang, 16.xii.1970 (AD); *S.T.W.Parfett 268*, 4 km N Zumsteins, 17.x.1999 (MEL, CANB); *F.Robbins sub A.C.Beauglehole 38734*, Eurobin Falls, 15.i.1951 (MEL); *R.V.Smith 73/30*, Cudgewa Bluff, 21.xi.1973 (MEL, NSW); *J.H.Willis MEL92608*, SW slopes of Pine Mtn, 17.xi.1964 (MEL); *J.H.Willis MEL92611*, Black Ra. Grampians, 2.i.1948 (MEL).

*Putative hybrids*

**(i) *K. ambigua* × *K. parvifolia*:** see 48. *K. ambigua*

**(ii) *K. capitata* subsp. *capitata* × *K. parvifolia*:** see 33a. *K. capitata* subsp. *capitata*

**(iii) *K. juniperoides* subsp. *pernernosa* × *K. parvifolia*:** see 26b. *K. juniperoides* subsp. *pernervosa*

**(vi) *K. occidentalis* × *K. parvifolia*:** see 47. *K. occidentalis*

**(v) *K. obovata* × *K. parvifolia*:** see 34. *K. obovata*

**(vi) *K. parvifolia* × *K. peduncularis*** (Molyneux & Forrester 2016, p. 53)

### 36. *Kunzea badjaensis* Toelken, *sp. nov.*

K. capitatae *subsp.* seminudae *similis sed habitu decumbenti et pilis brevis adpressus in ramis, foliis et floribus; a* K. obovata *habitu decumbenti, pilis adpressis in foliis floribusque et sine pilis in apice ovariis; a* K. parvifolia *habitu decumbenti, foliis magnis et perulis brevioribis differt.*

**Type:** New South Wales, 4 km SE Wadbilliga Trig., *I.R.Telford 12025*, 20.1.1994 (holo.: AD99426049; iso.: CANB (CBG9400401); BISH, MEL, NSW, n.v.).

*Kunzea sp. C* Joy Thomps. in S.W.L.Jacobs & Pickard (ed.), Pl. New South Wales 166 (1981); Peter G.Wilson in G.J. Harden (ed.), Fl. New South Wales 2: 152 (1991); de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

*Kunzea sp. Wadbilliga (Rodd 6168)* Peter G.Wilson in G.J. Harden (ed.), Fl. New South Wales, ed. 2, 2: 176 (2002).

Shrubs 0.2–0.5 (–1) m tall, with decumbent branches rarely ascending; young branches with leaf bases slightly raised but flanges absent to scarcely visible, pubescent to glabrescent with short hairs ± appressed; early bark scarcely fluted, peeling in membranous oblong pieces with ± straight margins. *Leaves* alternate; *petiole* (0.3–) 0.5–1.2 mm long, appressed; *lamina* oblanceolate to obovate, (1.5–) 2.5–5 (–6) × (0.8–) 1.4–2.5 (–4.1) mm, acute to obtuse, rarely truncate and ± abruptly constricted into a recurved apex, gradually tapering into petiole, concave to shallow-canaliculate above, convex and often with ridged main vein below, puberulous with short hairs ± appressed below and on the margins. *Inflorescence* a rounded botryum with (1–) 3–6 (–10) flowers, apparently terminal on long shoot but mainly on short shoots, with terminal vegetative growth often continuing while flowering or fruiting; *retained perules* 2–5, narrow-triangular to rarely broad-triangular, with 1–3 veins, usually appressed-pubescent; *bracts* ovate to oblong-elliptic, (1.7–) 2–3.5 × 1.2–2.2 mm, 3-veined, ciliate, tomentose to puberulous on upper half and glabrous below; *bracteoles* in pairs oblong-lanceolate to elliptic, (1.2–) 1.5–3 × 0.6–0.8 mm, with one central vein, tomentose to puberulous on upper half and glabrous below. *Hypanthium* 2.6–3.5 mm long when flowering (free tube 1.5–1.9 mm), tomentose to glabrescent with short appressed hairs often coiled. *Calyx lobes* triangular to narrow-triangular, 0.9–1.3 mm long, usually pointed, glabrescent to rarely tomentose and often with marginal cilia. *Corolla lobes* obovate, 1.2–1.5 mm long, scarcely erose, white, pink or mauve. *Stamens* (28–) 32–37, in more than one whorl; *filaments* 3.2–3.6 mm long; *anthers* broadly ellipsoidal, 0.5–0.6 mm long, with subterminal gland. *Ovary* 3-locular, with style slightly sunk into the sometimes ± hairy surface; *placenta* a fleshy round disc with short central attachment, scarcely bilobed with each lobe with 2 rows of ovules; *ovules* 16–20 per locule, spreading to erect above but lower 4 or 5 pendulous and often slightly longer; *style* 3.7–3.8 mm long, with stigma small-capi-

tate, scarcely compressed at the apex. *Fruit* an urceolate capsule with erect calyx lobes. *Seeds* not seen. *Flowering*: (November) December–January. **Fig. 13.**

*Distribution and ecology*. Grows on clay soil or often on shallow skeletal soil on acidic rocks such as sandstone, locally common in heathland with, for instance *Allocasuarina nana* and *Banksia canei*, or as understory to open woodland, but known only from a few, often widely separated localities, mainly in the Kybean Range of New South Wales (ST).

*Conservation status*. Locally common (e.g. *R.G.Coveny 5962*) but known only from few populations, most of which occur in Deua and Wadbilliga National Parks.

*Diagnostic features*. The leaves of this species are obovate or rarely oblanceolate as in *K. obovata*, but unlike that species they have indistinctly recurved apices, which are usually obtuse to cuspidate even when young. *Kunzea badjaensis* is best distinguished from the latter by its short appressed hairs on the hypanthium and calyx, if at all present, and its decumbent habit. The decumbent habit will also immediately distinguish it from *K. parvifolia*, which has commonly oblong, almost flat leaves with a double apex.

*Variation*. Plants from Badja Hill and the northern parts of the distribution area are decumbent, have white petals, larger and almost glabrous leaves, and usually no hairs on the apex of the ovary. These would seem quite distinct from the ascending plants from the Tuross River area, which have pink to purple petals, shorter tomentulose leaves and usually a tomentose apex to the ovary if it were not for two collections from near Wadbilliga trig (*I.R. Telford 8582, 12021*). The latter plants also have a spreading habit together with pink flowers and glabrescent intermediate leaves and few hairs on the apex of the ovary.

*Note*. A white-flowered form with a decumbent habit is registered as *Kunzea* 'Badja Carpet' and used as a ground cover in horticulture (Elliot & Jones 1993).

*Specimens examined*

New South Wales: *D.Binns 605 et al.*, S Dampier Trig., 18.xii.1982 (NSW); *B.G.Briggs NSW120222*, Tuross Falls, 26.iv.1968 (CANB, NSW); *J.D.Briggs & M.Parris 2080*, 300 m W Kydra Trig., 28.x.1986 (CANB); *J.D.Briggs & P.H. Weston 1817*, bluff 2.4 km N Wadbilliga Trig., 27.iii.1985 (CANB); *J.D.Briggs & P.H.Weston 1843,* 2 km SW Dampier Trig., Deua N.P., 28.iii.1983 (CANB, MEL); *R.G. Coveny 5962 & A.N.Rodd*, 2 km S Dampier Trig., 14.i.1975 (NSW); *M.D.Crisp 2393a & D.J.Cummings*, E of Big Badja Hill, 1.xii.1976 (CANB); *D.J.Cummings 49 & M.D.Crisp*, Big Badja Hill Trig. Pt, 2.xii.1976 (CANB); *E.Gauba CBG11473*, Mt Badja, 6.i.1950 (CANB, MEL); *J.Liney 2050*, Tuross Falls, 8.xii.2003 (CANB); *I.Olsen 2374*, N end of Wadbilliga Mtn plateau, 13.x.1974 (NSW); *A.E.Orme 608 & J.Whyte*, c. 50 m E Throsby Mtn Trig. 17.ii.2006 (NSW); *A.N.Rodd 6168*, Razorback Fire Trail, 25.i.1991 (NSW); *H.Streimann CBG52917*, Big Badja Mtn, 16.I.1974 (CANB, NSW); *I.R. Telford 10118*, Tuross Falls, 17.xi.1985 (AD, CANB, NSW); *I.R.Telford 12021*, Razorback Fire Trail, 1 km SW Wadbilliga Trig., 20.i.1994 (AD, CANB, NSW); *I.R.Telford 8582 & N.Ollerenshaw*, 4 km SW Wadbilliga Trig., 9.xii.1980 (AD, CANB, NSW); *M.D.Tindale 4011 et al.*, Kydra Reefs fire trail, 17.i.1972 (NSW); *J.H.Willis MEL92637*, Kydra Pks, 11.i.1970 (MEL).

### 37. *Kunzea opposita* F.Muell.

Fragm. 6: 24 (1867); Maiden & Betche, Proc. Linn. Soc. New South Wales 30: 364 (1905); Census N.S.W. Pl. 154 (1916); N.C.W.Beadle, Student Fl. N.E. New South Wales 3: 477 (1976); Byrnes, Austrobaileya 1(5): 468 (1982); T.D.Stanley in T.D.Stanley & E.M.Ross (eds), Fl. S.E. Queensland 2: 133, fig 18A (1986); Peter G.Wilson (1991) in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); A.R.Bean in R.J.F.Henderson (ed.), Queensland Pl. 133 (1997). — **Type:** New South Wales, granite rocks near Timbarra, *C.Stuart s.n.*, Nov. (lecto., designated here: MEL82191; isolecto.: MEL82193). **Remaining syn.**: Tablelands, *C.Stuart 288*, Dec. (MEL82192, MEL92825); New England, *C.Stuart* (K000843016, K000843017, MEL 92823, cf. Typification).

Shrubs 0.5–1.5 (–2.5) m tall, often spindly-branched; young branches with scarcely raised leaf bases and flanges usually absent, glabrous to hirsute with antrorse, often crisped hairs; early bark splitting in long longitudinal strips with almost membranous margins ± peeling to sometimes becoming corky. *Leaves* opposite to subopposite, rarely alternate; *petioles* 0–0.3 mm long, appressed; *lamina* lanceolate to linear-lanceolate, 1–2.5 (–5.5) × 0.7–1.1 mm, obtuse to rarely acute, usually gradually tapering into apex, abruptly constricted at the base, straight or loosely appressed, with margins incurved and ± furrowed above, strongly convex below, glabrous rarely puberulous below. *Inflorescence* a rounded botryum with (3–) 5–9 (–14) spreading flowers, apparently terminal to main and predominantly to shorter lateral branches, with vegetative growth usually continued laterally from below the inflorescence; *retained perules* up to 5, but often absent or with leaf-like fleshy apex, narrowly triangular-lanceolate to -ovate, 1.2–1.8 mm long, with clasping base, with central vein continued into point (often with well developed straight lateral veins), sericeous, puberulous to glabrescent; *bracts* ovate to elliptic-lanceolate above, (1.6–) 2.2–2.8 (–3.2) × (0.8–) 1–2 (–2.4) mm, acuminate and sometimes fleshy apex, with pronounced central vein and usually 2 lateral ones, hirsute to glabrous or with marginal hairs; *bracteoles* in pairs, linear-lanceolate, linear-elliptic to -oblanceolate and usually somewhat falcate, (0.7–) 1–1.5 (–1.8) × (0.4–) 0.5–0.9 (–1.3) mm, with pronounced central vein continued into acuminate or acute apex, hirsute to glabrous but often with marginal hairs. *Hypanthium* 3.2–3.6 mm long when flowering (free tube 1.5–1.8 mm long), becoming slightly angular, pubescent to hirsute, rarely glabrous. *Calyx lobes* triangular-ovate, (0.5–) 0.7–1 (–1.2) mm long, acute, ± ridged towards the apex, hirsute to glabrous with spreading antrorse hairs. *Corolla lobes* oblong-obovate to broadly obovate, 1.2–1.4 mm long, pink. *Stamens* (36–) 40–50 in more than one

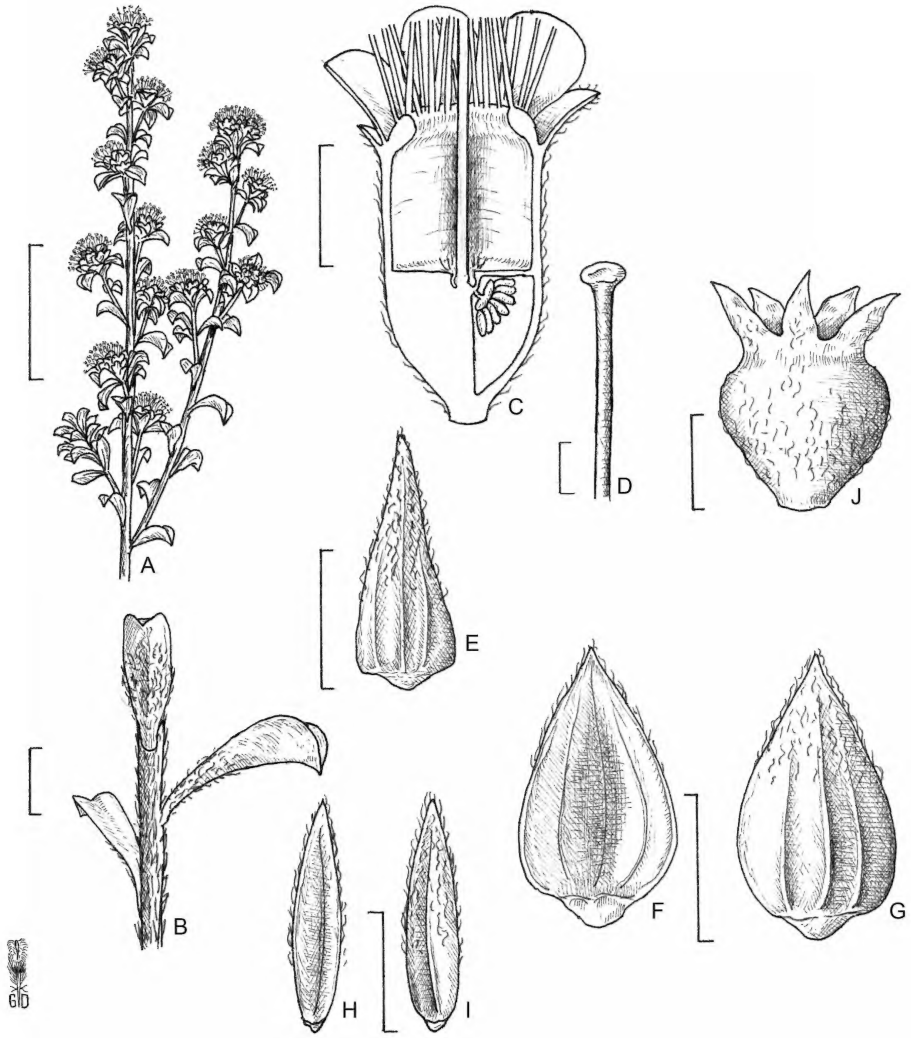


**Fig. 13.** ***K. badjaensis***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** capitate stigma; **E** abaxial view of perule; **F** adaxial view of bract; **G** abaxial view of bract; **H** adaxial view of bracteole; **I** abaxial view of bracteole; **J** fruit. — Scale bars: **A** 5 cm; **B** 1 mm; **C, D, J** 2 mm; **E–I** 1.1 mm. — **A–I** *D.Binns 605* (NSW); **J** *B.G.Briggs NSW120222.*

whorl, *filaments* 3.1–4.6 mm long; *anthers* broadly ellipsoidal, 0.3–0.45 mm long, with red subterminal gland. *Ovary* 3 (4)-locular, with style somewhat sunk into the upper surface, which varies from glabrous to hairy or hairy only along the sutures; *placenta* an almost round thick disk with short attachment just below the centre, scarcely lobed, each lobe with 3 (4) rows of ovules; *ovules* 21–76 per locule, subequal, spreading; *style* 4.2–5.6 mm long; stigma moderately capitate, scarcely compressed apically. *Fruit* an urceolate capsule with spreading to slightly incurved calyx lobes. *Seeds* angular cylindrical, c. 0.5 mm long; testa hard with dense vertical rugose ribbing.

*Diagnostic features.* The opposite or subopposite leaves of *K. opposita* and *K. calida* may be confused with the the very densely clustered ones of *K. juniperoides*, *K. muelleri* and *K.dactylota*, but those of the former two are deeply furrowed to rolled and especially the bracts and bracteoles have membranous margins, while leaves of the latter three species are slightly grooved above and the bracts and bracteoles scale-like chartaceous. *Kunzea calida* is very similar to *K. opposita* var. *leich-*

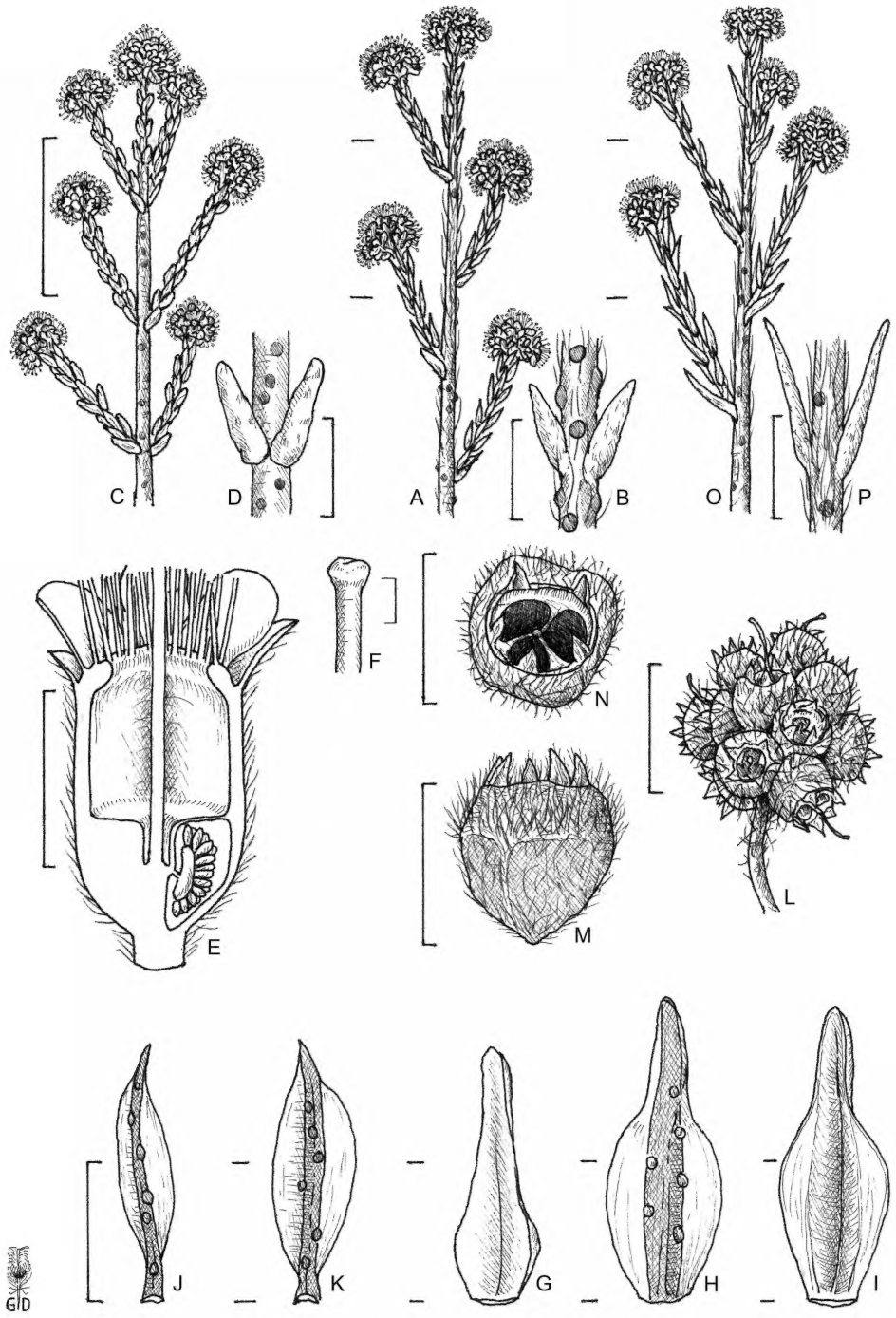


**Fig. 14. A–N *K. opposita* var. *opposita***: **A–B**, **E–N** NSW form: **A** flowering branch, **B** cauline leaves pointed. **C–D** Qld form: **C** flowering branch, **D** cauline leaves blunt and ± amplexicaule; **E** half flower; **F** capitate stigma. **G** adaxial view of perule; **H** adaxial view of bract; **I** abaxial view of bract; **J, K** ab-

*hardtii* (see Variation, below), but is distinguished by its linear conduplicate leaves, and the longer bracts and bracteoles.

The fine spreading lateral branches around the more robust main branches resemble the habit of *K. parvifolia* and it has often been confused, particularly in Queensland, with that species (Byrnes 1982), but is distinguished from *K. opposita* by its linear-oblanceolate to oblanceolate leaves with an abaxial ridge ending in a more or less developed subterminal point or double apex. These leaves are always spirally arranged, while they are usually opposite to subopposite in *K. opposita*. However, records from near Howell (New South Wales) of a form with spirally arranged leaves with more or less recurved apex are distinctly lanceolate as compared with oblanceolate or oblong in *K. parvifolia* from that area (cf. variation 3 of *K. parvifolia*). Both these species are so variable that hybridization or introgression would be very difficult to recognise and could only be assessed in detailed population studies. No distinct putative hybrids between the two species have here been recognised in spite of the unaccountable range of variation in north-eastern New South Wales.

The much intricately branched habit and the lateral branching, commonly from below the inflorescence rather than from the terminal bud, is reminiscent of the growth in species of sect. *Zeanuk* subsect. *Floridae* (Toelken 1996) except that the epidermis of the latter branches peels slough-like, seeds are ± smooth and petals are usually relatively larger to the stamens.

*Typification*. On two of the several sheets of C. Stuart's collections of *K. opposita* in MEL the type locality Timbarra is mentioned and, as sheet MEL82191 is accompanied by a collector's label, it is selected here as lectotype. The second sheet MEL82193 with only one of the blue handwritten labels of Mueller's herbarium contains four branches is regarded as isolectotype. It seems, however, that C. Stuart collected the species at least twice during that stay in New England, as, for instance, MEL82192 bears a collector's label with "288/ fl. Red/ Highest granite rocks/ Tableland/ (Dec)". This specimen was collected in December while sheet MEL 82191 was in November. As these specimens other than the lectotype and its duplicate also bear the same Mueller labels of the time it is highly likely that he had consulted them, as well. They are therefore accepted as syntypes. Specimens annotated as types and sent to K by F. Mueller lack detail to identify them correctly.

**Key to varieties**

1. Leaf lamina (0.8–) 1–2.5 (–3.8) mm long; hairs on branches 0.3–1 mm long .... **37a. *Kunzea opposita* var. *opposita***
1: Leaf lamina (3.1–) 3.8–5.2 (–5.8) mm long; hairs on branches longer than 1 mm ..... **37b. *Kunzea opposita* var. *leichhardtii***

**37a. *Kunzea opposita* Byrnes var. *opposita***

Austrobaileya 1: 468 (1982); A.R.Bean in R.J.F.Henderson, Queensland Pl.:133 (1997).

Young branches pubescent, glabrescent, rarely shortly sericeous with hairs 0.3–1 mm long. *Leaves* subopposite to opposite, rarely alternate, with lamina (0.8–) 1–2.5 (–3.8) mm long. *Flowering*: (August) September–November. **Fig. 14A–N.**

*Distribution and ecology*. Grows mainly in sandy soil usually associated with granite or sandstone rocks in open forest to woodland or exposed cliffs; recorded from often widely separated localities in south-eastern Queensland (BN, DD, LE) and northern New South Wales (NC, NT, NWS).

*Conservation status*. Widespread, locally frequent and conserved in several parks.

*Variation*. Plants of this typical subspecies from different areas show a wide diversity in indumentum, varying from glabrous to sericeous, which may vary on different parts of the plants from different areas. Interesting is that plants from the Nandewar Range are usually distinguished by a hairy upper surface of the ovary or sometimes specimens from north of these mountains have hairs on both sides of the sutures along which the capsules dehisce. This unusual character has also been observed in *K. parvifolia* and *K. occidentalis* from this area, but was, as in *K. opposita*, usually absent in other populations.

The leaves vary from opposite, more or less appressed to almost amplexicaul with rounded apices (cf. fig. 14D) on the Northern Tableland of New South Wales, while northwards in much of Queensland they are becoming more often subopposite to alternate with usually more or less spreading pointed apices (cf. fig. 14B). In the northern areas of the distribution of the species a definite increase in the length of the leaves is observed of which those of var. *leichhardtii* (cf. fig. 14P) are extremes. Intermediate leaf sizes, such as (1.6–) 2–3 (–3.8) mm in *P.I.Forster 11667 & P.Machin* (Headwaters of Pariagara Ck, 7 km W Bringalily Forestry lookout fire tower) and (1.7–) 2.2–3.1 (–3.4) mm in *Story & Yapp 307* (Planet Ck, c. 30 mls NE Rolleston), indicate that var. *leichhardtii* is possibly the extreme within a stepped cline and therefore the status quo is retained, i.e. the taxon is only recognised at variety level. However, *K. calida*, which is also very similar to var. *leichhardtii*, is for lack of evidence and due to the rarity of both taxa, retained as a separate species.

Considerable variation in the shape and size of the bract and bracteoles and in their tomentum has also been recorded. Unusual in this species are the large and often bulging oil glands on the branches. In some forms they are more clustered than in others (cf. fig. 14).

axial view of bracteoles; **L** infructescence; **M** fruit in side view; **N** dehisced fruit from above. **O, P *K. opposita var. leichhardtii***: **O** flowering branch; **P** cauline leaves. — Scale bars: **A, C, O** 15 mm; **B, D, M, N, P** 2.5 mm; **E** 2 mm; **F** 0.5 mm; **G–K** 1 mm; **L** 5 mm. — **A, B, E, F** *R.H.Cambage 2418* (NSW); **C, D** *D.O'Grady NSW124127*; **G–K** *U.Johnson 6/74* (BRI); **L–N** *J.H.Maiden & J.L.Boorman NSW124128*; **O, P** *R.J.Henderson 972* (BRI).

*Selection of specimens examined (64 seen)*

Queensland: *A.R.Bean 12565*, c. 6 km ESE Brovinia, 9.xi.1997 (AD, BRI); *R.C.Beasley BRI274329*, near Giligulgul, 22.ix.1941 (BRI); *L.A.Craven 9959 & Matarczyck*, 3.1 km W Amiens P.O., 16.x.1997 (CANB); *P.I.Forster 11667 & P.Machin*, Headwaters of Pariagara Ck, 7 km W of Brangalily Forest Lookout fire tower, 26.ix.1992 (AD, BRI); *P.I. Forster 29600 & D.A.Halford*, Badgery Holding, Wondul Ra., 7.xi.2003 (AD, CANB); *C.E.Hubbard 5110*, Wandoan near Gurulmundi, 17.xi.1930 (BRI); *K.McArthur BRI49200*, Tara, ix.1958 (BRI); *M.E.Phillips CBG15665*, Gurulmundi, 24.viii.1961 (BRI, CANB); *M.M.Richardson 258, et al.*, 5.5 km Gurulmundi Siding to Woleebee, 20.ix.1988 (AD, CANB); *E.J.Rider 40*, Gulera, 8.x.1968 (BRI); *Story & Yapp 307*, Planet Ck, c. 30 mls [48 km] NE Rolleston, 30.ix.1962 (BRI, CANB, K, MEL); *S.R.Stevens BRI41129*, Barakula NW Chinchilla, 21.x.1957 (BRI); *I.R.Telford 8880*, 13 km Cecil Plains to Millmerran, 10.xi.1982 (AD, CANB, MEL); *C.T. White s.n.*, Inglewood, xi.1922 (BRI274333, NSW124132); *P.G.Wilson 1572 & G.Towler*, 35.3 km S Wandoan, 18.iv.2002 (CANB, NSW).

New South Wales: *E.F.Constable 7067*, Big Spirabo Mtn, 22.viii.1966 (BRI, K, NSW); *L.M.Copeland 3475*, 15 km S Inverell along road to Bundarra, 10.xii.2002 (CANB, NSW); *R.G.Coveney 12729 et al.*, towards Dawson Springs, Mt Kaputar N.P., 25.viii.1987 (AD, NSW; BRI, CANB, HO, MEL, PERTH, n.v.); *R.H.Cambage 2418*, Mt Lindsay, xi.1909 (BRI, NSW); *E.N.McKie BRI274327*, Guyra, s.dat. (BRI); *J.H.Maiden & J.L.Boorman NSW124128*, Howell, viii.1905 (K, NSW); *M.Melvaine NSW124130*, 20 mls [32 km] W Uralla, 4.ii.1968 (NSW); *R.D.O'Grady NSW24127*, near Ramornie, 18.ix.1965 (NSW); *W.Schofield NE36989*, Mt Dowe, Nandewar Ra., 1.iii.1965 (NE, NSW); *W.R.Weiley NSW124122*, Copmanhurst, ix.1959 (NSW); *J.B.Williams NE36984*, 13 km E Tingha, 21.xii.1971 (NE); *H.J.Wissmann NE36992*, near Gilgai, x.1971 (NE).

*Putative hybrid*

**(i) *K. obovata* × *K. opposita* var. *opposita*:** see 37. *K. obovata*.

**(ii) *K. occidentalis* × *K. opposita var. opposita*:** see 47. *K. occidentalis*.

### 37b. *Kunzea opposita* var. *leichhardtii* Byrnes

Austrobaileya 1: 470 (1982); A.R.Bean in R.J.F.Henderson, Queensland Pl. 133 (1997). — **Type**: Queensland, Blackdown Tableland, c. 35 km SE Blackwater, *R.J.Henderson 972*, *L.Durrington & P.Sharpe*, ix.1971 (holo.: BRI 182140; iso.: CANB307507, MEL92581, NSW).

Young branches sericeous, with hairs commonly at least 1 mm long. *Leaves* alternate, subopposite or rarely opposite, with lamina (3.1–) 3.8–5.2 (–5.8) mm long. *Flowering*: August, September. **Fig. 14O, P.**

*Distribution and ecology.* Grows on shallow sandy soil on sandstone in open *Eucalyptus-Angophora* forest and known only from the Blackdown Tableland, Queensland (LE).

*Conservation status.* The frequency of this variety is unknown, but it was recorded from and it is conserved in Blackdown Tableland National Park.

*Variation.* The second collection of this variety examined (*C.H.Gittins 900*) showed a wider range of variation of the leaf length (3.1–5.8 mm long) than represented in the protologue.

*Specimens examined*

Queensland: *C.H.Gittins 900*, Third Ck, Blackdown Tableland, viii.1964 (BRI, NSW).

### 38. *Kunzea calida* F.Muell.

Fragm. 6: 23 (1867); F.M.Bailey, Syn. Queensland Fl. 168 (1883); Queensland Fl. 2: 592 (1900); Byrnes, Austrobaileya 1(5): 470 (1982); A.R.Bean in R.J.F. Henderson (ed.), Queensland Pl. 133 (1997). — **Type**: Queensland, Newcastle Range, at sources of the Flinders River, *J.Sutherland s.n.* (lecto., designated here: MEL 560102; isolecto.: K000843018).

Additional measurements and information obtained from a cultivated specimen (*A.Griinke s.n.* based on seeds from *E.J.Thompson 338 & H.A.Dillewaard*) is presented in square brackets.

Spreading shrubs to 1.5 m tall; young branches with scarcely raised leaf bases and flanges absent, sericeous with mainly ± appressed long silky antrorse hairs but also some often coiled shorter ones; early bark flaking into shortly oblong to almost square membranous flakes with irregular margins. *Leaves* opposite, subopposite [alternate on long shoots]; *petioles* 0–0.2 [–0.5] mm long, appressed; *lamina* linear-lanceolate to linear-oblanceolate but usually rolled and linear, (2.9–) 3.5–7.9 [–15.6] × 0.45–0.6 [–1.6] mm, erect, obtuse to usually rounded, scarcely constricted towards the apex and base, above concave to ± rolled, below usually strongly convex with central vein not visible, sericeous on both sides. *Inflorescence* a ± rounded botryum with 3–12 flowers, apparently terminal to main branches and some short shoots subtending these, with vegetative growth continuing from the terminal bud and/or from below the inflorescence after flowering; *retained perules* 0–3, linear-lanceolate, 1.5–1.7 mm long, with scarcely visible central vein to the apex, hirsute; *bracts* lanceolate to linear-lanceolate, 4.3–6.2 [–8.4] × 1.1–1.7 mm, with acuminate apex on lower flowers to linear leaves with sheathing base on upper flowers, with 1 vein but often obscured by central ridge, hirsute with long spreading antrorse hairs; *bracteoles* in pairs, linear-elliptic rarely -oblanceolate, often somewhat falcate, 2.8–3.5 (–3.7) × 2.2–3.6 mm, with pronounced central ridge above the central vein, hirsute with spreading hairs. *Hypanthium* 3.4–3.6 [–4] mm long when flowering (free tube 1.2–1.4 mm long), almost globular or slightly angular, hirsute with long spreading antrorse hairs over few often coiled shorter ones. *Calyx lobes* triangular, 1.2–1.5 mm long, acute to acuminate because the margins are ± incurved, hirsute with spreading antrorse hairs rarely glabrescent. *Corolla lobes* obovate to oblong-obovate, 0.9–1.2 mm long, pinkish-purple. *Stamens* 50–64 in more than one whorl; *filaments* c. 3.5 mm long; *anthers* broadly ellipsoidal, 0.35–4 mm long, with ± distinct subterminal

gland. *Ovary* 3-locular, with style ± sunk into the upper surface being glabrous to hairy along the sutures; *placenta* an almost round disk with short central attachment, scarcely lobed, each lobe with 3 or 4 rows of ovules; *ovules* 35–42 per locule, spreading; *style* 5.2–7.8 mm long, with stigma capitate, scarcely compressed at the apex. *Fruit* an almost spherical capsule, with calyx ± recurved to 90° of the central axis. *Seeds* few per locule maturing, cylindrical to somewhat crescent-shaped, terete to slightly angular-terete; testa soft, pale brown, finely scalariform-rugose. *Flowering*: September.

*Distribution and ecology.* "On top of mountain, in flat rocky open area" of the Mount Stewart Ranges, Queensland (NK).

*Conservation status.* A very rare species and although a few plants of this species were found in 1991/92, they could not be relocated recently. An endangered species on schedule 2 in Queensland (Bostock & Holland 2015) or 3K in Briggs & Leigh (1996).

*Diagnostic features.* The leaves of *K. calida* are rolled and thus appear to be terete unlike the more conical leaves with furrowed upper surface of *K. opposita* var. *opposita*. The leaves are, however, similar to those in *K. opposita* var. *leichhardtii* except that they are usually even longer and densely hairy (sericeous).

*Variation.* The collections examined are very similar except that the sutures along the upper surface of the ovary are hairy in the type specimen while they are glabrous on the specimen *E.J.Thompson 338 & H.A.Dillewaard*. The leaves of a specimen cultivated by Mr Allen Griinke from seeds of the latter collection are about twice as long and very distinct from those of *K. opposita* var. *leichhardtii*.

*Note*. A specimen without date or collector, consisting of only one inflorescence, but with No 22 (MEL556943), is correctly identified as this species, except that the provenance is given as "Pentland Hill/ Flinders & Burdakin [rivers]".

*Typification*. The type specimen of *K. calida* in Mueller's herbarium (MEL56102), with one of his typical blue labels, is accompanied by a minute packet of the same blue paper, in which numerous immature seeds ("gemmulis") are wrapped, as described by Mueller (1867). As the author did not designate a holotype this specimen is selected as lectotype.

*Specimens examined*

Queensland: *A.Griinke ex E.J.Thompson 338 & H.A. Dillewaard*, cultivated 2002 (AD); *E.J.Thompson 338 & H.A.Dillewaard*, Mt Stewart Ranges, 22.ix.1991 (BRI); *E.J. Thompson CHA199 & P.R.Sharpe*, 9.5 km W Hmsd, 83 km SW Charters Towers, 30.viii.1992 (AD, CANB, MEL; A, BISH, DNA, K, KEP, L, MBA, NSW, NY, PERTH, PNH, PR, PRE, SAN, SAR, n.v.).

## C. *Kunzea* subgen. *Angasomyrtus* (Trudgen & Keighery) de Lange & Toelken

in de Lange et al., Austral. Syst. Bot. 23: 317 (2010). — *Angasomyrtus* Trudgen & Keighery, Nuytsia 4(3): 435, fig. 1 (1983). — **Type species:** *Kunzea salina* (Trudgen & Keighery) de Lange & Toelken.

Main branches with short branches (sometimes short shoots) in the axil of all leaves; branches with raised decurrent leaf bases, but not flanged, with epidermis splitting into long longitudinal ridges, becoming corky bark. *Inflorescence* an elongate botryum with 2 or 3 (–6) flowers continued terminally into ± vegetative growth before, while and after flowering; *bracts* fleshy leaf-like, caducous; bracteoles thin membranous, caducous. *Flowers* sessile, mature buds pointed. *Stamens* unequally long, shorter than petals, incurved. *Ovary* with 2 or 3 (–4) locules, each with peltate placenta with 4 or 5 pendulous elongate ovules; *style* short and scarcely longer than free tube of hypanthium.

*Discussion*. In spite of the obvious similarity of this species to *Kunzea*, it shows no close resemblance to any of the existing species, so that it was first described as the monotypic genus *Angasomyrtus* (Trudgen & Keighery 1983). Even the unusual feature of opposite leaves in *K. opposita*, could not be compared to those of *K. salina*, as it combines them with axillary short shoots in many leaf axils. Furthermore *K. salina* was described with monads instead of the typical globose botrya and two whorls of stamens of different length. This last characteristic is shared with species of *K. ericoides* complex (=*Kunzea* subgen. *Niviferae* sect. *Niviferae*) and additional material (*L.A.Craven et al. 9098*) confirmed that the inflorescence, originally described as a monad was a seasonally reduced botryum with leaf-like caducous bracts and bracteoles as well as terminal growth concurrent with flowering. However, *K. salina*, unlike the *K. ericoides* complex, has a pointed conical apex to flower buds, lacks a funnel-shaped stigma and well developed flanged decurrent leaf bases. Even under favourable conditions it usually produces only one short shoot in the axil of one of the opposite leaves (*L.A.Craven et al. 9098*).

Resulting from molecular research by O'Brien et al. (2000), *Angasomyrtus* was placed into *Kunzea.* In their detailed molecular study of the genus *Kunzea* de Lange et al. (2010) established it as a separate subgenus next to subgen. *Kunzea* in central position.

### 39. *Kunzea salina* (Trudgen & Keighery) de Lange & Toelken

in de Lange et al., Austral. Syst. Bot. 23: 318 (2010). — *Angasomyrtus salina* Trudgen & Keighery, Nuytsia 4(3): 435, fig. 1 (1983). — **Type:** Western Australia, S Truslove on reserve 27983, *A.Hopkins 77/27 & M.E.Trudgen*, 8.ii. 1977 (holo.: PERTH, n.v.; iso.: CANB; NSW, K, n.v.).

Low shrubs up to 0.4 m tall and spreading to 2 m across, much-branched; branches with raised decurrent leaf bases rarely flanged, shortly sericeous to pubescent;

early bark splitting into long longitudinal strips, becoming corky ridges, not peeling. *Leaves* opposite, but often ± shifted by unequal branching in the axils; *petiole* 0.4–1 mm long, ± appressed; *lamina* linear-oblanceolate to linear-elliptic, (2.6–) 3.5–6 (–7.3) × (0.5–) 0.8–1.3 (–1.8) mm, acute to obtuse, often becoming rounded, gradually tapering into petiole, straight erect, ± furrowed above, usually strongly convex below, puberulous above and on margins, soon glabrescent. *Inflorescence* a botryum with 2 (–6) sessile flowers, at base of new shoots developing above the perules, with vegetative growth continuing above it; *retained perules* 3–5, ovate-triangular at base to narrowly oblong or elliptic higher up, (0.8–) 1.5–3 mm long, blunt to rounded apex, slightly fleshy (veins not visible) with membranous margins, sericeous especially on margins, caducous to deciduous; *bracts* linear-elliptic, (2.8–) 3.3–4 × 1–1.4 mm, ± fleshy with veins not visible, puberulous to glabrescent, caducous to deciduous; *bracteoles* in pairs, linear-oblanceolate, rarely linear-lanceolate, 1.3–1.5 × 0.3–0.6 mm, acute to pointed, ± fleshy with veins not visible, sericeous, usually caducous. *Hypanthium* 2.7–3 mm long when flowering (free tube c. 0.4 mm long), sericeous to pubescent. *Calyx lobes* ovate-triangular, 0.5–0.7 mm long, acute to pointed, puberulous to glabrous but usually with marginal cilia when young. *Corolla* lobes broadly obovate to suborbicular, about twice the size of calyx lobes, pale pink to white. *Stamens* 16–19 in two whorls; *filaments* terete, unequally long, curved introrse; *anthers* broadly ellipsoidal, 2–2.5 mm long, with bold terminal gland. *Ovary* 2 or 3 (–4)-locular, with style slightly sunk into the upper surface, glabrous above; *placenta* a rounded peltate disc, scarcely lobed and with 4 or 5 subequal pendulous ovules; *styles* 1–1.2 mm long, broadened towards the base, with truncate, scarcely broadened stigma. *Fruit* an urceolate capsule with erect to spreading calyx lobes. *Seeds* angular cylindrical, 1–1.2 mm long; testa with fine vertical ribs. *Flowering*: November–February, but variable with season. **Fig. Nuytsia 4: 437, fig. 1.**

*Distribution and ecology*. The species grows in a rare habitat, a combination of "white sand dunes over clay at the margins of small playa lakes" with *Tecticornia uniflora* to *Melaleuca/Eucalyptus* shrubland communities (Trudgen & Keighery 1983).

*Conservation status*. *Kunzea salina* is a "rare species of restricted habitat and restricted range" which is conserved in Truslove Reserve (Trudgen & Keighery 1983); it is listed as a Priority 3 species (poorly-known) by the Western Australian Herbarium (1998–).

*Variation*. Although *K. salina* develops obvious buds or branches in most leaf axils, as it is commonly observed on species of sections *Pallidiflorae* and *Niviferae*, these are often not short shoots, since some will develop into long branches. In addition, the opposite leaves, which are unusual in the genus, but also found in, for instance, *K. opposita*, are frequently pushed out of position by developing axillary branches.

**Key to species of sections *Platyphylla* and *Pallidiflorae* of subgen. *Niviferae***

**1.** Seasonal growth flush above infructescence develops at few nodes; axillary branches of varying length
- **2.** Flower buds truncate; leaves linear and glabrous, 11.6–17.3 mm long; Qld (NK) . . . . . **45. *K. truncata***
- **2:** Flower buds acute-conical; leaves oblanceolate to elliptic and pubescent to puberulous, rarely up to 12 mm long
  - **3.** Bracts broader or about as broad as long
    - **4.** Calyx glabrous or almost so; Qld (DD), N.S.W. (NT) . . . . . **41. *K. bracteolata***
    - **4:** Calyx covered with long silky hairs; Qld (SK) . . . . . **43. *K. sericothrix***
  - **3:** Bracts usually twice longer than broad
    - **5.** Hypanthium and calyx pubescent to puberulous; bracts and bracteoles deciduous, rarely persisting on upper fruits; Qld (BN, DD, MO, PC, WB) . . . . . **40. *K. flavescens***
    - **5:** Hypanthium and calyx glabrous; bracts and bracteoles caducous
      - **6.** Branches below the inflorescence with few short appressed hairs mainly between flanges; abaxial leaf glands not extending to margins; Qld (NK) . . . . . **42. *K. graniticola***
      - **6:** Branches below the inflorescence pubescent to hirsute; abaxial leaf glands extending close to margins; Qld (PC) . . . . . **44. *K. caduca***

**1:** Seasonal growth flush above infructescence develops at all nodes of axillary branches, but they remain often only short shoots as long or shorter than subtending leaf
- **7.** Flower buds with acute-conical apex; style 3–8.4 mm long; stamens subequally long (except in *K. petrophila*)
  - **8.** Bracts acuminate; plants densely hirsute with long spreading hairs; N.T. (VR) . . . . . **46. *K. petrophila***
  - **8:** Bracts acute to obtuse or rarely emarginate; plants pubescent, shortly hirsute to glabrescent
    - **9.** Bracts similar to leaves and persistent; branches glabrous or almost so; N.S.W. (NC) . . . . . **49. *K. axillaris***
    - **9:** Bracts scale-like; branches shortly hirsute, pubescent to glabrescent
      - **10.** Branches puberulous to glabrescent, then developing white flanges; N.S.W. (NWS, CWS, NWP) . . . . . **47. *K. occidentalis***
      - **10:** Branches shortly hirsute to pubescent, rarely glabrescent obscuring usually grey flanges; NSW (CC, SC, CT, ST), Vic. (EG, GPL, PROM), Tas. (FI, NE, EC) . . . . . **48. *K. ambigua***
- **7:** Flower buds truncate; style 1.5–2.5 mm long; stamens unequally long (Qld, N.S.W., Vic., New Zealand) . . . . . ***K. ericoides* complex** (= ***Kunzea* sect. *Niviferae***; in prep.)

*Specimen examined*

Western Australia: *L.A.Craven et al. 9098*, at junction of Lagoon and Kendall Roads, Scaddan, 10.xi.1992 (AD).

## D. *Kunzea* subgen. *Niviferae* Toelken & de Lange

in de Lange et al., Austral. Syst. Bot. 23: 317 (2010). — **Type species:** *K. peduncularis* F.Muell.

*Kunzea* sect. '*Eukunzea*' Benth., Fl. Austral. 3: 112 (1867), pro parte, quoad *K. corifolia* (synomym of *K. ambigua*), *K. peduncularis* – nom. inval..

Main branches usually regularly branching with short shoots in the axils of all leaves, except irregular growth in growth flushes and rarely short shoots in most species of sect. *Platyphyllae*; branches with raised, usually flanged decurrent leaf bases except in some species of sect. *Platyphyllae*; epidermis of branches splitting into long longitudinal ridges becoming ± corky or with ± peeling bark. *Inflorescence* a ± elongated botryum with (3–) 6–∞ stalked or sessile flowers without or usually with few to many terminal leaves, but if botrya are ± globose then with (1–) 3–24 mainly sessile flowers without terminal leaves or only few in most species of sect. *Platyphyllae*, growth after flowering terminal; *bracts* and *bracteoles* ± fleshy leaf-like to membranous and caducous, or deciduous and ± scale-like chartaceous mainly in species of sect. *Platyphyllae*. *Flowers* stalked or sessile, mature buds acute-conical (in species of sections *Platyphylla* and *Pallidiflorae*) to truncate (mainly in species of sect. *Niviferae*). *Stamens* erect, as long as and/or longer than petals, often unequally long with shorter ones, mainly shorter than petals and ± incurved in species of sect. *Niviferae*. *Ovary* 3–5 locules, each with peltate placenta with usually more than 20 short spreading ovules; *style* as long as stamens, or shorter and rarely scarcely longer than the calyx lobes in species of sect. *Niviferae*.

*Discussion*. The subgenus is divided into three sections: *Platyphyllae*, *Pallidiflorae* and *Niviferae*. Only the first two sections are described in detail in this paper, sect. *Niviferae* is currently under revision and will be published separately.

A morphologically very variable group. Species of sect. *Platyphyllae* share with species of subgen. *Kunzea* a number of characters, such as the globular inflorescence, scale-like bracts and bracteoles, which are persistent to deciduous, and irregular growth in growth flushes. The species of sect. *Pallidiflorae* show much more similarity to species of sect. *Niviferae*, particularly as *K. axillaris* has not only an elongate inflorescence with often some terminal leaves, but also stalked flowers in contrast to *K. ambigua* and *K. occidentalis* (sect. *Pallidiflorae*). Species of sect. *Pallidiflorae* differ, however, from those of sect. *Niviferae* by their subequal long erect stamens, acute-conical apices of mature flower buds and a long style placing the stigma at about the level of the anthers.

The molecular support (de Lange et al. 2010, fig. 1) for the separation of clade B (subgen. *Kunzea*) and clade C (subgen. *Niviferae*) is only moderate (BS = 84%). It is also noteworthy that on clade C the terminal branches of species of sect. *Platyphyllae*, especially of *K. graniticola* and *K. caduca*, are unusually long, in comparison to the very short branches of species of the sections *Pallidiflorae* and *Niviferae*.

Species of sect. *Platyphyllae* occur predominantly on the Great Divide in Queensland, but *K. bracteolata* also enters into northern New South Wales and *K. petrophila* occurs very locally in the dry parts of the Northern Territory. *Kunzea ambigua*, the most widespread species of sect. *Pallidiflorae*, shows a distribution from coastal ranges of central New South Wales southwards through eastern Victoria into Tasmania. Sect. *Niviferae* has largest number of species, with six in Australia and ten recorded from the North and South Island of New Zealand (de Lange 2014). The Australian species are distributed from southern Queensland southwards mainly along the southern ranges of the Great Divide into eastern Victoria.

### D.1. *Kunzea* sect. *Platyphyllae* Toelken & de Lange

in de Lange et al., Austral. Syst. Bot. 23: 317 (2010). — **Type species:** *K. flavescens* C.T.White & Francis.

Distal main branches few and irregularly branching, rarely regularly branching from each node in *K. petrophila* and these new branches are usually longer than the subtending leaf or ending in flowers; leaf base not flanged. *Inflorescence* globose, rarely spiciform; mature flower buds acute-conical, rarely truncate in *K. truncata*, rarely obtuse with subequal calyx lobes; bracts and bracteoles usually scale-like and deciduous, rarely membranous and caducous; stamens subequal and erect-spreading, longer than petals but subequal to style; petals white.

*Discussion*. A heterogeneous group of species with more or less flat straight leaves, or leaves scarcely folded and/or recurved in *K. bracteolata* and *K. flavescens*, but without "pinched apex" as commonly found in the somewhat similar species of subgen. *Kunzea*. They are mainly based in Queensland with *K. bracteolata* extending into northern New South Wales, and *K. petrophila* occurring only in the Northern Territory. The latter differs in having regular growth with short shoots developing in all leaf axils, as is typical to species in sections *Pallidiflorae* and *Niviferae*. Also, the decurrent leaf bases develop into flanges with incurved margins. *Kunzea petrophila* also shows much variation of the inflorescence, as both globular and elongate ones may be found on the same branch, but, in contrast to *K. ciliata* (Toelken 1996, p. 66), the elongate inflorescences, which are often subtended by small globular ones, do not seem to be environmentally induced. *Kunzea petrophila* is morphologically not easily placed (cf. Diagnostic features of species), especially as it produces, similar to *K. caduca* and *K. truncata*, stamens of two different lengths, a character typical of species of sect. *Nivifera*,

but molecular evidence places *K. truncata* and *K. petrophila* as sister taxa clearly into this section. *Kunzea truncata* is also unusual in this section, because it has truncate mature buds, which resemble those of species of sect. *Niviferae*, but the inflorescences of the two sections differ.

**40. *Kunzea flavescens* C.T.White & Francis**

Proc. Roy. Soc. Queensland 33: 155 (1922); Byrnes, Austrobaileya 1(5): 468 (1982); T.D.Stanley in T.D.Stanley & E.M.Ross (eds), Fl. S.E. Queensland 2: 132 (1986); A.R.Bean in R.J.F.Henderson (ed.), Queensland Pl. 133 (1997). — **Type:** Queensland, Crows Nest, *F.H.Kenny s.n.*, xi.1921 (lecto., designated here: BRI-AQ278373; isolecto.: K000800998, MEL92306, MEL92307, NSW).

Spreading shrubs or trees rarely up to 7 m tall; young branches with leaf bases scarcely raised and flanges rarely well developed, pubescent, rarely hirsute, with ± spreading antrorse hairs; early bark repeatedly longitudinally splitting, corky and not peeling or rarely with papery margins. *Leaves* alternate; *petioles* 0.5–0.9 mm long, appressed; *lamina* oblong-oblanceolate, rarely oblong-elliptic, 4–7 (–7.8) × (1.2–) 2–2.5 (–3.1) mm, cuspidate to acuminate, rarely acute, gradually tapering into petiole, erect-spreading, above flat to slightly concave, with or without obvious glands, below scarcely convex, with usually > 60 oil glands, which are usually absent close to the margins, pubescent to puberulous mainly above, rarely glabrescent but with marginal short antrorse, usually appressed hairs at least when young. *Inflorescence* a rounded to slightly elongated botryum with 8–15 ± spreading flowers, apparently terminal on main branches and short lateral shoots below the apex; with terminal vegetative growth continuing after flowering; *retained perules* 2–8, narrowly triangular to rarely ovate, 0.6–1.2 mm long, acute, with or without mucro, 1 (–3)-veined, usually glabrous; *bracts* ovate to broadly elliptic, 3.3–3.8 × 1.8–2.2 mm, cuspidate to acute on upper flowers, 3 (–5)-veined, glabrous or with few hairs mainly along the central ridge and with ± marginal cilia; *bracteoles* in pairs, broadly ovate to ovate, 2.5–3.2 × 2–3 mm, obtuse, truncate or emarginate, 1 (–3)-veined, with scattered hairs and ± developed marginal cilia. *Hypanthium* 3–3.5 mm long when flowering (free tube c. 1.3 mm long), longer than bracts, ± ridged, pubescent with spreading short antrorse hairs. *Calyx lobes* narrowly triangular, 1.4–1.8 mm long, acute, somewhat ridged, puberulous to glabrous with short antrorse hairs at least on the margins. *Corolla lobes* oblong-obovate, 1.4–1.7 mm long, white or cream. *Stamens* c. 50, in several rows; *filaments* 2.2–3.5 mm long; *anthers* broadly ellipsoidal, c. 0.45 mm long, with pronounced subterminal gland. *Ovary* 3-locular, with style usually deeply sunk into upper surface; *placenta* an oblong-elliptic disc with short off-centre attachment in lower third, scarcely divided into two lobes, each with 4 rows of ovules; *ovules* 39–45 per locule, spreading; *style* 3.8–5 mm long with stigma broadly capitate, slightly compressed at apex. *Fruit* a cylindic-urceolate capsule, 4.5–5 mm long, with erect-spreading calyx lobes. *Seeds* irregular obpyramidal to angular cylindrical, often slightly curved, c. 0.6 mm long; testa hard, dark brownish-red, with vertical rugulose scalariform ribs. *Flowering*: Mainly September, October. **Fig. 15.**

*Distribution & ecology.* Grows on granite or sandstone in open eucalypt forest, sometimes locally common but usually locally restricted in south-eastern Queensland (BN, DD, MO, PC, WB).

*Conservation status.* For a long time this species was known from a single area near Crows Nest, but, although it is now known from a number of localities, it still has a restricted occurrence, including Mt Walsh National Park. (3RC in Briggs & Leigh 1996).

*Diagnostic features. Kunzea flavescens* is similar to *K. bracteolata* but distinguished by distinctly spreading leaves (at c. 90º to branches), ± hairy calyx lobes, and rounded to emarginate apices of bracts.

*Variation.* The indumentum on leaves varies considerably in density and especially the length of the long hairs on plants from different localities. The distinctive antrorse marginal hairs vary little and are usually the last to wear off. Furthermore the hairs on the hypanthium and particularly the calyx also vary considerably and at times are already glabrescent at flowering (e.g. *W.H. Pilkington BRI501590*).

*Notes.* The number of ovules per locule was erroneously described in the protologue as "with a single ovule in each cell", but this was corrected by Byrnes (1982). The species resembles more closely *K. bracteolata* than *K. cambagei* as claimed by the original author.

*Typification.* Since no holotype was designated in the protologue the specimen in BRI, which is accompanied by the collector's label, is selected as a lectotype.

*Specimens examined*

Queensland: *A.R.Bean 7701*, Mt Walsh N.P., 21.vi.1994 (BRI); *A.R.Bean 8540*, Warro S.F., 6.iv.1995 (BRI); *A.R.Bean 14431*, near Monto, E Scrubby Dam, 11.xii.1998 (BRI, MEL); *A.R.Bean 19616*, S.F. 132, Allies Ck, S Mundubbera, 26.xi.2002 (BRI); *L.J.Brass s.n.*, Crows Nest, iv.1924 (CANB); *L.A.Craven 9975 & J.A.Matarczyck*, Mt Walsh, near Biggenden, 18.x.1997 (CANB); *W.Curtis BRI546315*, sandstone plateau, Plunkett S.F., 23.viii.1992 (BRI); *L.Durrington 621*, 3 km E Crows Nest, 3.iv.1972 (BRI, K); *P.I.Forster 5761*, Beeron Holding, 5 km W Toondahra Hmsd, 9.ix.1989 (BRI, MEL, MO, BISH); *P.I.Forster 31083,* Beeron Holding, SSW Mundubbera, 26.ix.2008 (BRI); *P.Grimshaw G553 & L.M.Grimshaw*, Wivenhoe View Estate, 22.iii.1994 (BRI); *R.Johnstone 470*, Biggenden Bluff, 27.vii.1994 (NSW); *T.E.Lanham BRI75099*, Crows Nest, 25.i.1967 (BRI); *M.E. Phillips CBG25309*, Crows Nest, 12.viii.1963 (CANB); *W.H.Pilkington BRI501590*, Goomburra Valley on Dalrymple Ck, 23.x.1990 (BRI); *J.W.Randall BRI188170*, Mt Walsh N.P., 3.ix.1973 (BRI); *I.R.Telford 5313*, Mt Walsh, S Biggenden, 28.iv.1977 (CANB); *I.R.Telford 11851 & J.Nightingale*, Crows Nest Ck, 4.xi.1993 (AD, CANB; BRI, MEL, NSW, n.v.); *T.Tyson-Donely 242*, Bloodwood Ck, 17.xii.2006 (BRI);

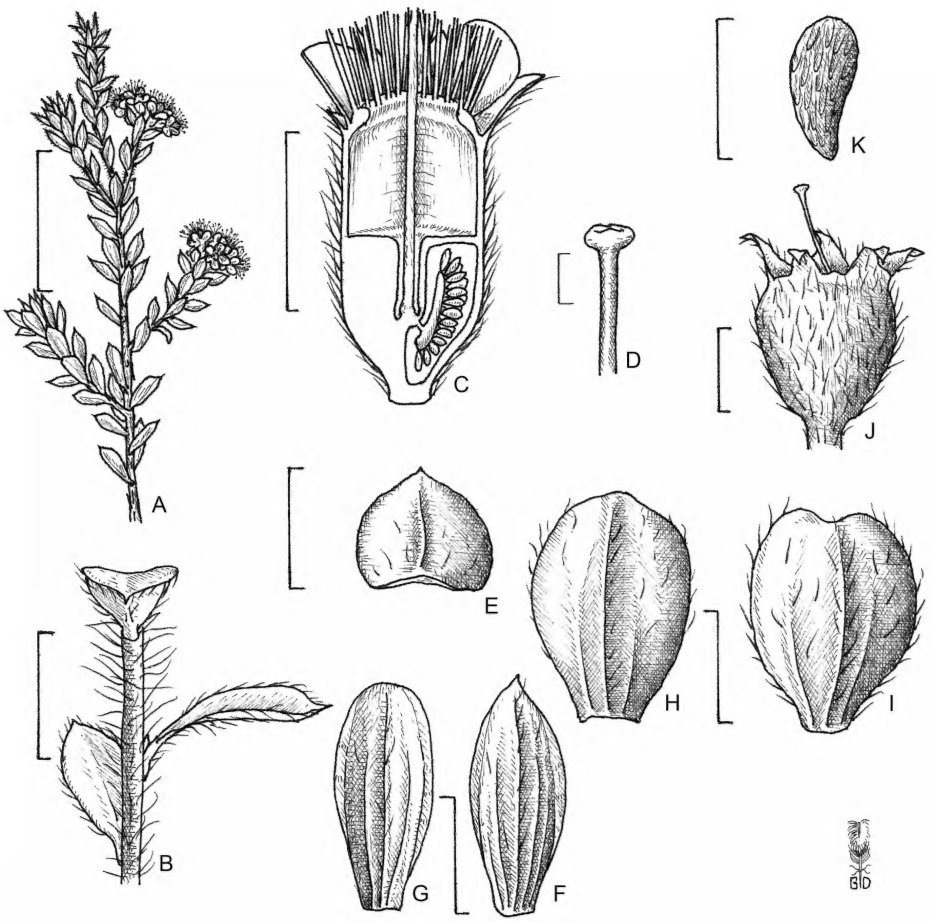


**Fig. 15.** ***K. flavescens***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** saucer-shaped stigma; **E** abaxial view of perule; **F** abaxial view of proximal bract; **G** abaxial view of distal bract; **H** abaxial view of proximal bracteole; **I** abaxial view of the distal bracteole; **J** fruit; **K** seed. — Scale bars: **A** 2.5 cm; **B, C** 2.5 mm; **D–I** 1.5 mm; **J** 2 mm; **K** 0.5 mm. — **A–I** *C.T.White 7317* (BRI); **J, K** *L.Durrington 621* (BRI).

*C.T.White 7317*, Biggenden Bluff, 13.x.1930 (BRI, K); *C.T. White BRI273811*, Crows Nest, x.1921 (BRI, NSW).

### 41. *Kunzea bracteolata* Maiden & Betche

Proc. Linn. Soc. New South Wales 30: 363 (1905); Maiden & Betche, Census N.S.W. Pl. 154 (1916); N.C.W.Beadle, Student Fl. N.E. New South Wales 3: 477 (1976); Byrnes, Austrobaileya 1(5): 469 (1982); T.D.Stanley in T.D.Stanley & E.M.Ross (eds), Fl. S.E. Queensland 2: 133 (1986); Peter G.Wilson (1991) in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); A.R.Bean in R.J.F. Henderson (ed.), Queensland Pl.: 133 (1997). — **Type:** Queensland, Wallangarra, *J.L.Boorman s.n.*, xi.1904 (lecto., designated here: NSW10607; isolecto.: BM, K000 843007, MEL92329).

Shrubs 1–2 (–3) m tall, erect; young branches with leaf bases somewhat raised and slightly decurrent but not flanged, pubescent to tomentose with short antrorse hairs; early bark splitting into slender longitudinal pieces, ± fibrous but becoming indistinct corky ridges. *Leaves* alternate; *petiole* 0.6–1 mm long, appressed; *lamina* elliptic to oblong-oblanceolate, rarely linear-lanceolate, (2.6–) 4–9 (–11) × (0.9–) 1.5–3.5 (–4.5) mm, acute to pointed, gradually or sometimes abruptly tapering into petiole, erect to recurved, above slightly concave, below slightly convex, with ∞ fine oil glands usually right to the ± horny margins, glabrous or puberulous with antrorse hairs at least along the margins. *Inflorescence* a rounded botryum with 6–12 (–18) flowers, apparently terminal on short and long branches, with terminal growth often at fruiting; *retained perules* few or absent, lanceolate to broadly ovate, 1.3–2.4 mm, 1–3-veined, with marginal cilia and sometimes

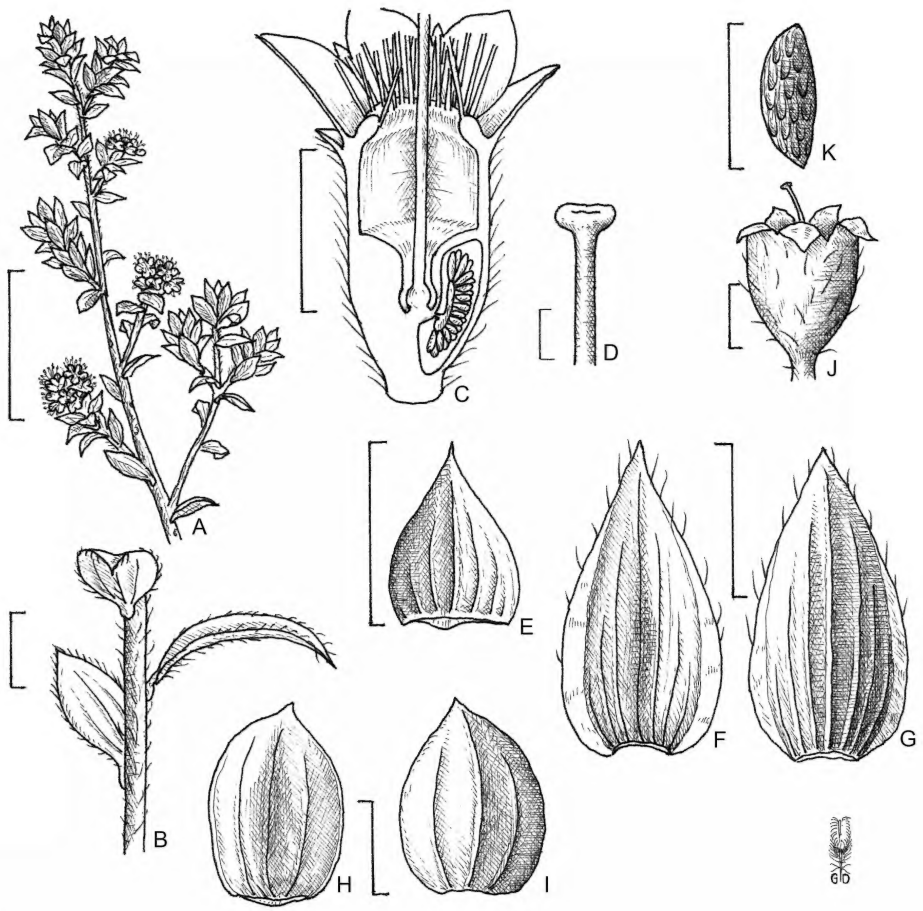


**Fig. 16.** ***K. bracteolata***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** saucer-shaped stigma; **E** abaxial view of perule; **F** adaxial view of bract; **G** abaxial view of bract; **H** adaxial view of bracteole; **I** abaxial view of bracteole; **J** fruit; **K** seed. — Scale bars: **A** 3 cm; **B** 2 mm; **C** 3 mm; **D, E, H, I** 1.5 mm; **F, G** 2.5 mm; **J** 2 mm; **K** 1 mm. — **A–I** *F.D.Hockings BRI113086*; **J, K** *J.B.Williams NSW124238*.

with few hairs mainly along the central vein; *bracts* broadly ovate and subauriculate basally, ovate on upper flowers, 4–5 × 4–4.5 mm, with 3–5 veins usually raised, with stiff central vein continued into acuminate to cuspidate apex, glabrous except for ± cilia along hyaline margins; *bracteoles* in pairs, obliquely ovate, 3.2–4 × 2.5–3 mm, obtuse to cuspidate, 1–3-veined, glabrous or with few marginal cilia. *Hypanthium* 3–4.2 mm long when flowering (free tube c. 2 mm long), about as long as bracts, often ridged, glabrous. *Calyx lobes* triangular, 1.5–1.8 (–2) mm long, apex acute to pointed and ± recurved, ridged to keeled, glabrous. *Corolla lobes* oblong-obovate to obovate, 1.8–2 mm long, cream. *Stamens* usually > 50, in more than one whorl, *filaments* 2.3–3.5 mm long; *anthers* broadly ellipsoidal, 0.4–0.55 mm long, with red subterminal gland. *Ovary* 3 (4)-locular, with style deeply sunk into the upper surface; *placenta* an elliptic disc with short off-centre attachment on lower third, scarcely divided into 2 lobes each with 3 or 4 rows of ovules; *ovules* 48–63 per locule, equal, spreading; *style* 5–5.8 mm long, with stigma broadly flat-capitate, with marked central depression. *Fruit* an urceolate to cup-shaped capsule, 4–4.5 mm long, with recurved calyx lobes. *Seeds* angular-cylindrical to obpyramidal, c. 1 mm long; testa firm, dark reddish-brown, vertically ribbed and rarely with oblique connections. *Flowering*: (October) November, December. **Fig. 16.**

*Distribution and ecology.* The species usually grows on skeletal sandy soil on granite rocks in heath-like vegetation often under eucalypt woodland in Queensland (DD) and northern New South Wales (NT).

*Conservation status.* Locally frequent and conserved in several National Parks. (3RC in Briggs & Leigh 1996).

*Diagnostic features.* Distinguished from other species in this section by its broadly ovate bracts with 3 to 5 distinctly raised veins, ridged to keeled pointed calyx lobes, and ± horny margins of the leaves. These broad bracts as well as the bracteoles are deciduous at the fruiting stage, unlike the caducous ones of the very similar *K. caduca* and *K. truncata*.

*Variation*. The indumentum on the branches can vary occasionally, even on the same plant, from usually pubescent to hirsute or glabrescent.

*Typification*. Several specimens of the collection, "J.L. Boorman; Nov.'04", exist, as cited in the protologue of *K. bracteolata*. As the authors did not designate a holotype, the sheet *J.L.Boorman NSW10607*, which is accompanied by Boorman's collector's information used in the protologue, is selected as the lectotype. The sheet (MEL92329) consists of three branchlets, which might have been derived from the lower branch of the lectotype.

*Specimens examined*

Queensland: *A.R.Bean 7155*, 4 km E Wyberba, 7.xii.1993 (NSW); *S.T.Blake 23678*, near Wyberba and Wallangarra, 2.xi.1971 (BRI); *T.J.Bowen BRI5774*, Amiens, 6.xi.1956 (BRI); *M.S.Clemens BRI273795*, near Ballandean, x.1944 (BRI); *C.W.Frazier & Hazlitt NE36957*, 400 m from Mountain View, Amiens, 6.x.1966 (NE); *F.D.Hockings BRI31420*, Wyberba, 1961 (BRI); *F.D.Hockings BRI113086*, Mt Norman, 6.xii.1970 (BRI); *W.J.F.McDonald BRI223925*, top of Slip Rock, 11.xi.1974 (BRI); *L.Pedley 1490*, Amiens, 30.x.1963 (BRI, CANB); *T.L.Ryan 54*, 1.6 km SE Mt Norman, 1.xii.1970 (BRI); *I.R.Telford 1506*, Mt Norman, 9.v.1970 (CANB, NSW); *I.R.Telford 2594*, 2 mls [3.2 km] NE Wallangarra, 29.xi.1970 (BRI, CANB, NSW); *I.R.Telford 3126*, Mt Norman, 25.ix.1973 (CANB).

New South Wales: *A.R.Bean 8239*, 14 km N Torrington, 28.i.1995 (NSW); *J.P.Burgess NSW124234*, 40 mls [64 km] E Glen Innes, 4.xii.1960 (NSW); *S.C.Clemesha NSW746210*, Granite picnic area, Washpool N.P., 15.xi.1998 (NSW); *L.A. Copeland 2716*, 100 m ENE Granite Pk, 10 km W Tenterfield, 18.x.2005 (CANB, NSW); *I.R.Telford 2638*, Warah Trig., NE Glen Innes, 27.xi.1970 (AD, CANB); *I.R.Telford 5176*, Bald Rock, 24.v.1977 (CANB); *J.B.Williams NSW124233*, 36 mls [57.6 km] E Glen Innes, vi.1954 (NSW); *J.B.Williams NSW124238*, 6 mls [9.6 km] N Torrington, 17.xii.1966 (NE, NSW); *J.B.Williams 587 & K.Winterhalder*, 42 mls [67.2 km] E Glen Innes, 5.x.1958 (NE, NSW); *P.G.Wilson 1686 & A.E.Orme*, c. 64.4 km E Glen Innes on Gwydir Hwy, 4.v.2005 (NSW); *H.J.Wissmann NE36854*, Bald Rock, 12.xi.1967 (NE).

*Putative hybrids*

***K. bracteolata* × *K. obovata***

The specimens have the less branched and more erect habit, stiffly erect, linear-oblanceolate to elliptic-oblanceolate erect leaves, and white petals of *K. bracteolata*. The bracts have 3 obvious veins and are covered like the hypanthium with long spreading hairs as is typical of *K. obovata*, which seem to occur nearby as the collector commented that "pink-flowered bushes of this species occurred nearby".

*Specimens examined*

Queensland: *M.E.Phillips CBG35788*, Myall Park (cultivated), Stanthorpe, 9.ix.1963 (CANB).

New South Wales: *J.B.Williams NE37010*, Boonoo Boonoo Falls, 6.x.1966 (NE).

*Putative parents from the area*

***K. bracteolata.*** New South Wales: *I.R.Telford 5176*, Bald Rock, 24.v.1977 (CANB); *H.J.Wissmann NE36854*, Bald Rock, 12.xi.1967 (NE).

***K. obovata.*** New South Wales: *J.C.Morrow BRI31347*, above Boonoo Boonoo Falls, 16.x.1960 (BRI); *M.E.Phillips CBG16413*, Boonoo Boonoo Falls, 21.ix.1966 (CANB, BRI).

### 42. *Kunzea graniticola* Byrnes

Austrobaileya 1(5): 468 (1982); A.R.Bean in R.J.F.Henderson (ed.), Queensland Pl. 133 (1997). — **Type:** Queensland, 16 km N Ingham, *R.Smith 8a*, 22.viii.1975 (holo.: BRI 197154; iso.: CANB378169).

Shrubs or small trees 2–3 (–4) m tall; young branches with scarcely raised leaf bases but with well developed flanges with incurved lateral margins, glabrous to puberulous or rarely pubescent mainly below inflorescences, with short ± appressed hairs particularly between flanges; early bark repeatedly splitting longitudinally with scarcely fibrous margins, usually corky and not peeling. *Leaves* alternate; *petiole* 0.2–0.5 mm long, flat, appressed; *lamina* linear-oblanceolate to -elliptic, (4–) 6–9 (–12) × 1–1.2 mm, acute, gradually tapering into petiole, with erect or scarcely recurved apex, above ± concave, without obvious glands, below convex and with 25–55 oil glands mainly along the central vein, glabrous, rarely with short marginal cilia when young. *Inflorescence* a rounded to slightly elongate botryum with (1–) 3–8 flowers, apparently terminal on all branches, with terminal growth after fruiting; *retained perules* rarely more than 3, elliptic to oblanceolate, 0.5–0.7 mm long, 1-veined, glabrous, lower persistent but upper ones caducous; *bracts* oblong-oblanceolate, 1.8–2.1 × 0.8–1.1 mm, obtuse, 3-veined, glabrous or with some cilia; *bracteoles* in pairs, oblong-oblanceolate, 1.5–1.8 × 0.6–1 mm, acute to obtuse, 1–3-veined, ciliolate to glabrous. *Hypanthium* 3.5–4 mm long when flowering (free tube 2–2.2 mm long), rarely ridged, glabrous. *Calyx lobes* usually broadly triangular, 1–1.5 mm long, acute, scarcely ridged towards the apex, glabrous. *Corolla lobes* broadly obovate, 1.8–2.2 mm, white to cream. *Stamens* 80 or more in several rows; *filaments* 3.6–4.2 mm long; *anthers* broadly ellipsoidal, 0.3–0.45 mm long, with short connective and prominent subterminal gland. *Ovary* 3-locular, with style somewhat sunk into the upper surface; *placenta* a narrowly oblong-elliptic disc with short central attachment, scarcely bilobed, each lobe with 2 rows of ovules; *ovules* 26–35 per locule, spreading; style 3.8–4.7 mm long; stigma broadly flat-capitate, scarcely compressed at apex. *Fruit* and *seed* not seen. *Flowering*: August, September. **Fig. 17.**

*Distribution and ecology*. Growing on often steep rocky slopes or on river banks usually associated with granite, but also recorded from sandstone, in open eucalypt forest; restricted to near Cardwell and Hinchinbrook Island, Queensland (NK).

*Conservation status.* The species is conserved to Hinchinbrook Island National Park. (2RC in Briggs & Leigh 1996).

*Diagnostic features.* The linear-oblanceolate to linear-elliptic leaves and the whole plant of *K. graniticola* are glabrous, in contrast to plants of other species of this section, except for *K. truncata*. *K. truncata* has longer leaves (11.3–17.6 mm) with abaxially numerous fine oil glands extending to the margins of the leaves, while in *K. graniticola* they are larger and restricted to along the central vein.

*Variation*. While the margins of the leaves of plants from Hinchinbrook Island are sharply edged, those from plants on the mainland are sharply edged only towards the base.

*Specimens examined*

Queensland: *S.T.Blake 18852*, Zoe Bay, Hinchinbrook Is., 21.viii.1951 (BRI); *N.B.Byrnes 3919*, Five Mile Ck, S Cardwell, 8.viii.1979 (BRI); *B.Jackes BRI181844*, Waterfall Ck, Cardwell Ra., 25.viii.1974 (BRI); *J.Donohue 6*, Waterfall Ck, Cardwell Ra., 25.viii.1973 (BRI); *J.Kemp TH2555*, c. 2 km NW Mt Diamantina, Hinchinbrook Is., 4.xii.2000 (CANB); *I.R.Telford 12151 & S.Donaldson*, lower E slopes of Bishop Pk, 2.viii.1996 (CANB); *I.R. Telford 13016 & J.J. Bruhl*, E of spur of Bishop Pk, 12.xi.2006 (AD, NSW); *A.G. & M.G.Thorsborne 297*, c. 8 km S Cardwell, 22.ix.1976 (BRI); *A.G. & M.G.Thorsborne BRI63027*, Mt Bowen, Hinchinbrook Is., 25.viii.1966 (BRI); *C.Warrian 7051*, Hinchinbrook Is., 28.x.1986 (BRI); *K.A.W.Williams 77234*, Five Mile Ck, S Cardwell, 21.ix.1977 (BRI).

### 43. *Kunzea sericothrix* Toelken, *sp. nov.*

*A* K. bracteolata *perulis linearo-triangularibus et pilis sericeis longissimis in ramis, foliis inflorescentiis differt.*

**Type:** Queensland, Dick's Tableland, Eungella National Park, *A.R.Bean 3672*, 3.ix.1991 (holo.: BRI508278).

*Kunzea sp. (Dicks Tableland A.R.Bean 3672)* A.R.Bean in R.J.F.Henderson (ed.), Queensland Pl. 133 (1997).

*Kunzea sp. L* de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

Shrub up to 0.5 m; young branches with leaf bases scarcely raised and without decurrent flanges, hirsute to sericeous with long antrorse hairs ± appressed; early bark splitting into slender longitudinal pieces with ± peeling margins. *Leaves* alternate; *petioles* 0–0.4 mm long, appressed; *lamina* linear-elliptic to -lanceolate, 5.3–6.5 (–8.2) × 1.2–2.0 mm, acute to pointed, gradually tapering into indistinct petiole, erect with somewhat recurved apex, above flat to concave or ± cymbiform, below ± convex, with glands not obvious, sericeous with long appressed antrorse hairs on both surfaces. *Inflorescence* a rounded botryum with 5–8 (–10) flowers, apparently terminal on main branches and short lateral shoots below it, with terminal growth not seen; *retained perules* 0–3, compressed-ovate, with base often shorter than oblong-triangular acumen, 3–3.5 mm long, 3–5-veined, sericeous; *bracts* broadly ovate with cuspidate to acuminate apex, 3.6–4 × 4–4.3 mm, (3–) 5-veined with often raised veins, sericeous; *bracteoles* in pairs, oblong-ovate, 3.2–4 × 2.2–2.5 mm, cuspidate to mucronate, 1–3-veined, sericeous. (Flower buds were immature, i.e. information measurements provided are provisional). *Hypanthium* longer than calyx (free tube slightly longer than ovary), sericeous. *Calyx lobes* triangular, 0.6–0.7 mm long, pointed, ridged, sericeous. *Corolla lobes* broadly elliptic to almost orbicular, 1.3–1.5 mm long. *Stamens* c. 40, in more than one whorl; *filaments* 0.9–1.8 mm long; *anthers* broadly ellipsoidal, 0.45 mm long, with subterminal gland. *Ovary* 2, 3-locular, with style deeply sunk into the upper surface; *placenta* an elliptic disc with short attachment in lower third; scarcely divided into 2 lobes each with 3 rows of ovules; *ovules* more than 45 per locule, equal, spreading; *style* 3.8–4 mm, broadened towards the base, with stigma flat-capitate, with slight central depression. *Fruit* and *seed* not seen. *Flowering*: September.

*Distribution and ecology.* Known only from type collection "in rocky watercourse, with *Callistemon viminalis* and *Leptospermum polygalifolium*" on the Dicks Tableland, Queensland (SK).

*Conservation status.* The type collection states "rare at site" in Eungella National Park. Nevertheless it is regarded as endangered in schedule 2 in Queensland (Bostock & Holland 2015).

*Diagnostic features. Kunzea sericothrix* is distinguished from all other species in this section by the combination of its linear leaves and long silky hairs on all parts of the plant, especially the hypanthium and calyx, and the perules with a short compressed-ovate base abruptly continued into a long oblong-triangular acumen. Although the long hairs of *K. flavescens* are usually more or less spreading (hirsute) a few specimens were observed with more adpressed hairs (sericeous), but in all cases the leaves were broader.

*Etymology.* The epithet "serico-thrix", Greek, "silky hair" refers the rather long fine hairs all over the plant.

### 44. *Kunzea caduca* Toelken, *sp. nov.*

*A* K. graniticola *et* K. truncata *ramis puberulis rare pubescentibus et foliorum basibus indistincte complanatis; affinis* K. flavescenti *sed bractis bracteolisque caducis, ramis puberulis, hypantheis glabris et obconicis in pedicello usque ad 1.4 mm longo differt.*

**Type:** Queensland, Mt Maria, *J.Brushe JB247*, 2.x.1995 (holo.: BRI 584365; iso.: NSW).

*Kunzea flavescens* auct. non C.T.White & Francis: A.R.Bean in R.J.F.Henderson (ed.), Queensland Pl. 133 (1997).

*Kunzea sp. K* de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

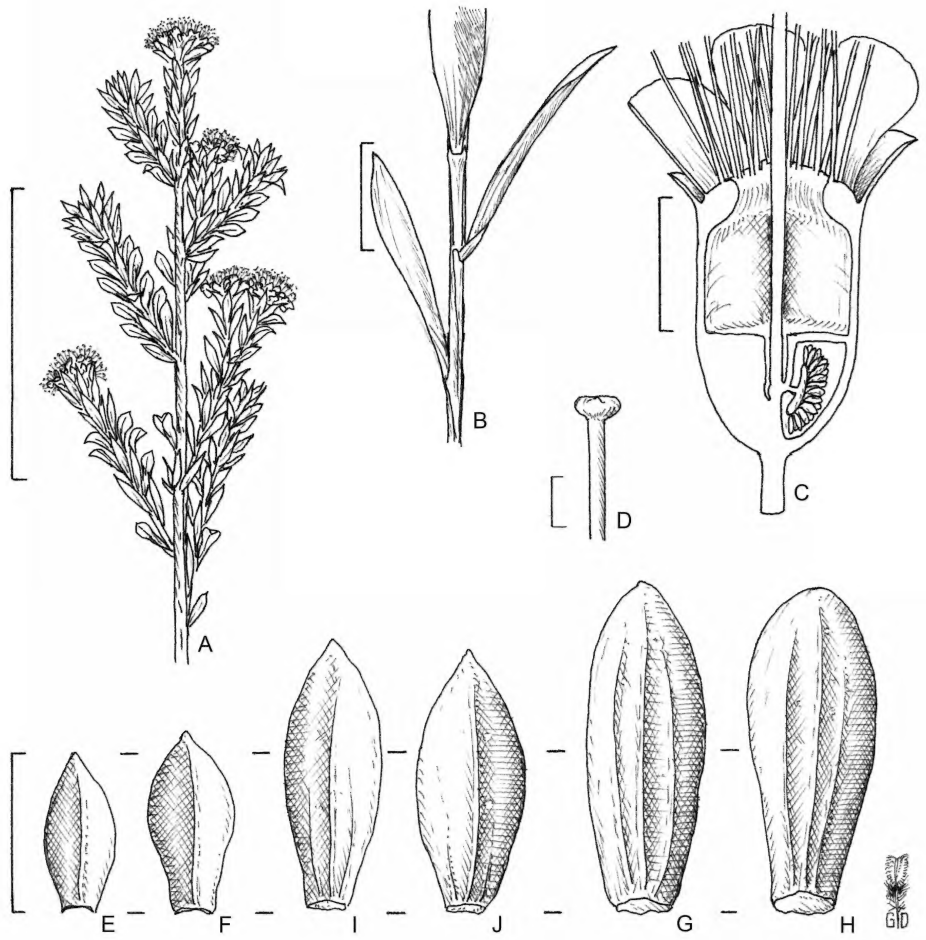


**Fig. 17.** ***K. graniticola***: **A** flowering branch; **B** cauline leaves; **C** half flower; **D** saucer-shaped stigma; **E, F** abaxial view of perules; **G** adaxial view of bract; **H** abaxial view of bract; **I** adaxial view of bracteole; **J** abaxial view of bracteole. — Scale bars: **A** 5 cm; **B, C** 2 mm; **D** 1.5 mm; **E–J** 1 mm. — **A, B** *K.A.W.Williams 77234* (BRI); **C–J** *R.Smith 8A* (BRI).

Spreading, often low shrubs up to 3 m tall; young branches with scarcely raised decurrent leaf bases in the form of ± well developed flanges each with incurved lateral margins at least at the base of leaf, pubescent to hirsute below and on inflorescences, with long and short spreading hairs; early bark repeatedly splitting longitudinally without fibrous margins, becoming corky. *Leaves* alternate; *petiole* 0.2–0.6 mm long, flat, appressed; *lamina* linear-oblanceolate to narrowly elliptic-oblanceolate, (3.8–) 5–9 (–10.8) × (1.1–) 1.4–2 (–2.5) mm, acute, gradually tapering into petiole, erect to rarely with scarcely recurved apex, above flat to ± concave, below convex and with > 60 coarse glands but rarely extending close to the margins, glabrous or glabrescent with few minute hairs at the abaxial base and often along its central vein and margins. *Inflorescence* a ± rounded botryum with (1–) 3–8 flowers, each with a short pedicel up to 1.4 mm long, apparently terminal on all branches, with terminal vegetative growth after fruiting; *retained perules* rarely more than 3, with compressed triangular-ovate base surmounted by acumen up to equal length, 0.45–0.8 mm long, 1-veined (often dark brown), glabrous, caducous but lowermost often retained; *bracts* ovate to oblong-ovate, 1.0–1.3 × 0.8–1.2 mm, pointed to cuspidate, ± incurved, 1–3-veined, scale-like chartaceous, glabrous to puberulous and/or with some short cilia; *bracteoles* oblong-ovate, 1.1–1.8 × 0.8–1 mm, obtuse rarely acute, 1-veined, membranous, ciliolate to glabrous. *Hypanthium* 3.5–4.1 mm long when flowering (free tube 2–2.2 mm long), obconical, rarely ridged, glabrous. *Calyx lobes* broadly triangular-ovate, 0.6–0.8 mm long, acute,

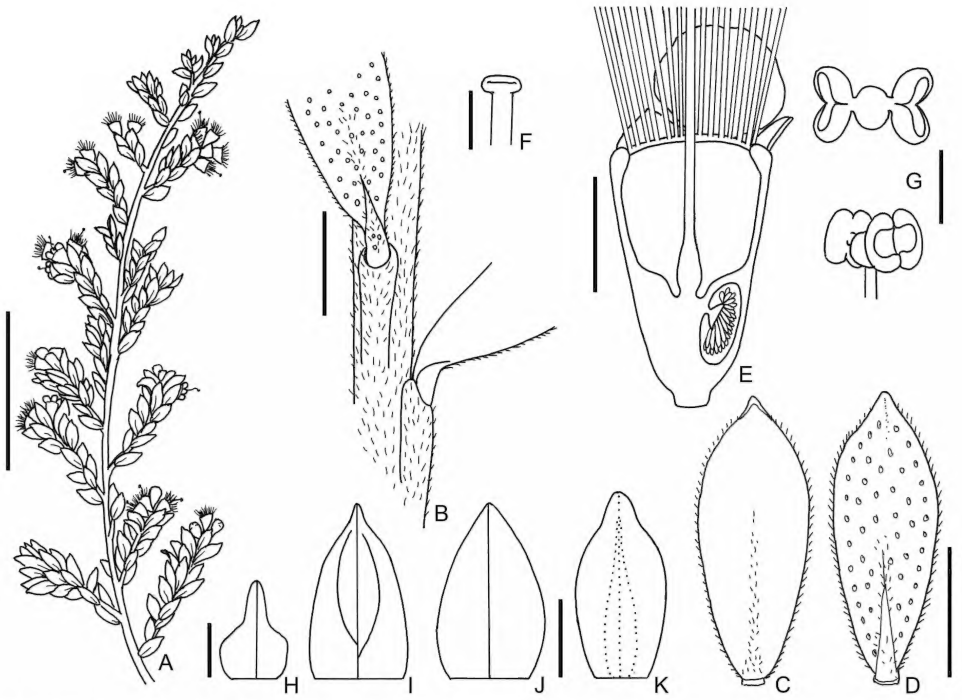


**Fig. 18.** ***K. caduca***: **A** flowering branch; **B** young branch with flanged decurrent leaf bases; **C** adaxial leaf surface without glands; **D** abaxial leaf surface with many glands but not close to the margins; **E** half flower; **F** saucer-shaped stigma; **G** anthers with lobes pushed apart by broad connective and gland; **H** abaxial view of perule; **I** adaxial view of bract; **J** abaxial view of bract; **K** adaxial view of bracteole. — Scale bars: **A** 3 cm; **B** 2 mm; **C, D** 4 mm; **E** 2 mm; **F, G** 0.5 mm; **H** 0.25 mm; **I–K** 0.5 mm. — **A–K** *J.Brushe 247* (BRI).

± ridged towards the apex, glabrous. *Corolla lobes* broadly obovate to oblong-obovate, 1.3–1.6 mm, entire to erose, white to cream. *Stamens* 48–56, in several rows; *filaments* 0.8–2.5 mm long, unequally long, with outer ones up to twice as long as inner ones; *anthers* broadly ellipsoidal, 0.3–0.4 mm long, twice as broad as long when dehisced, with red subterminal gland. *Ovary* 3-locular, with style base somewhat sunk into the upper surface; *placenta* an oblong-elliptic disc with short central attachment, scarcely bilobed, each lobe with 3 or 4 rows of ovules; *ovules* 34–40 per locule, spreading or the lower ones pendulous and slightly longer; *style* 3.8–4.4 mm long, with stigma broadly flat-capitate, scarcely compressed in the apex. *Fruit* a ± cup-shaped capsule, slightly flared below the calyx lobes, 3.1–3.5 mm long, with erect but slightly incurved calyx lobes. *Seed* irregularly pyramidal, c. 1 mm long, dark brown, with scalariform vertical ridges. *Flowering*: August, September. **Fig. 18.**

*Distribution and ecology.* Growing on steep hills or mountains on black sandy loam with acid intrusive rocks; forming an often sparse mid stratum which is dominated by *K. caduca* and *Xanthorrhoea latifolia* subsp. *latifolia* in low open woodland/shrubland dominated by *Eucalyptus exserta*, other eucalypts and *Lophostemon confertus*; known only from one locality in Queensland (PC).

*Conservation status.* At present the species is known only from few localities but it is conserved in Mt Castle Tower National Park.

*Diagnostic features. Kunzea caduca* superficially resembles *K. graniticola*, but is distinguished by short scattered hairs on branches and fewer stamens (more than 80 in *K. graniticola*), which are of different lengths. Stamens of different length on the same flower are also encountered in *K. truncata* and *K. petrophila* in sect. *Platyphylla* and it is a common feature of species of sect. *Niviferae*. The short hairs and short leaves distinguish *K. caduca* from *K. truncata*, while *K. petrophila* differs by linear leaves and being covered with long spreading hairs. Furthermore, *K. caduca* differs from *K. flavescens* by few short hairs along branches (puberulous) and the glabrous hypanthium (both hirsute in *K. flavescens*), bracts and bracteoles that are caducous and unequally long stamens.

*Notes.* The filaments of the stamens vary somewhat and the shortest ones are centripetally placed. This condition was also observed in *K. truncata* and *K. graniticola*, except that in these cases the length difference of indivi-

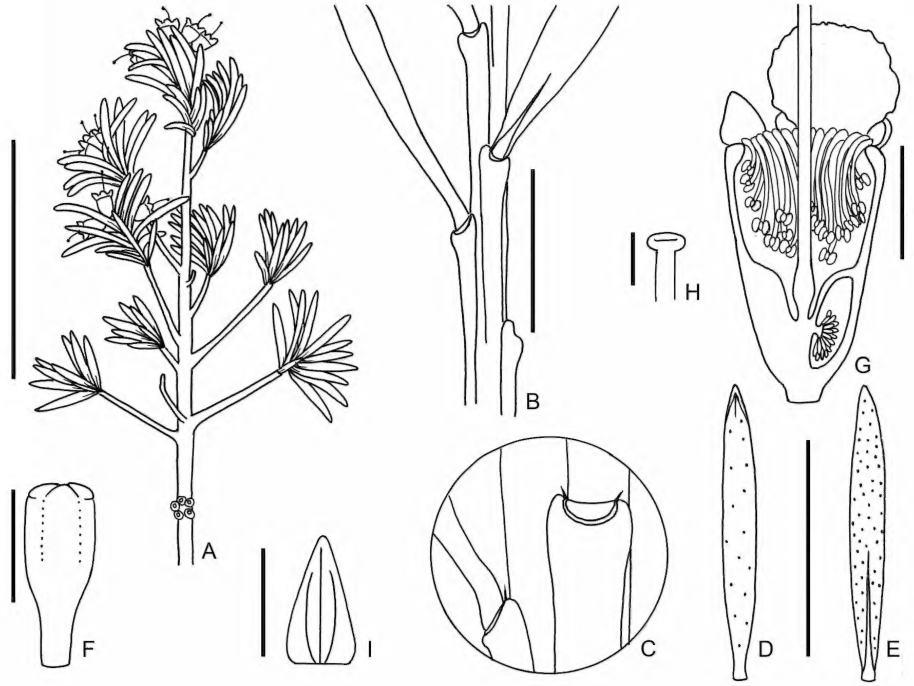


**Fig. 19.** ***K. truncata***: **A** flowering branch; **B** young branch with flanged decurrent leaf bases (**C** close-up); **D** adaxial leaf surface with few glands; **E** abaxial leaf surface with many glands with some close to the margin; **F** truncate mature flower bud; **G** half flower; **H** saucer-shaped stigma; **I** abaxial view of perule. — Scale bars: **A** 3 cm; **B** 5 mm; **C, D** 10 mm; **E** 4 mm; **F** 2 mm; **G** 0.5 mm; **H** 2 mm. — **A–H** *R.J.Cumming 11309* (BRI).

dual filaments was not so obvious and might relate to the progressive maturing (from the outside to the inside) of the anthers together with some additional final expansion and stretching of the filaments as sometimes observed in *K. ambigua*. More field observations are needed.

In *K. caduca* the connective and the gland are both reddish-brown in dried specimens, so that it is difficult to discern one from the other. Once the anthers are dehisced the shell of each theca (with two opposite pollen sacs) remains wing-like expanded on opposite sides of the large, almost round gland-connective-sphere. The latter seems to dominate the whole anther, making it broader than long, because the two lateral thecae, each with two functional pollen sacs, are very much shorter than those of *K. graniticola* and *K. truncata*. The anthers of *K. caduca* are very short and, in spite of its obvious nature, the gland-connective sphere is only marginally larger than in *K. graniticola*.

*Typification*. The description was predominantly based on *J.Brushe JB247*, which is here selected as the holotype, although the fruiting specimen, A.*R.Bean 6998* (paratype), was also consulted and there are more widely distributed duplicates available of this specimen.

*Etymology*. The epithet "caduca", Latin, "dropping off early" refers to the bracts and bracteoles, which are shed usually well before anthesis.

*Specimens examined*

Queensland: *A.R.Bean 6998*, Mt Maria, 18. xi.1993 (AD, BRI; K, MEL); *P.I.Forster 16339*, E slopes of Many Peaks Ra., Mt Castle Tower N.P., 20.xi.1995 (MEL).

### 45. *Kunzea truncata* Toelken, *sp. nov.*

*A* K. caduca *et* K. graniticola *ramis glabris foliisque longioribus et glandulis parvioribus foliorum in paginis abaxillaribus et adaxillaribus differt.*

**Type:** Queensland, Yamanie National Park, *R.J. Cumming 11309*, 27.viii.1991 (holo.: BRI 540676).

*Kunzea sp. (Herbert River R.J. Cumming 11309)* A.R.Bean in R.J.F.Henderson (ed.), Queensland Pl. 133 (1997).

*Kunzea sp.* K.A.Williams, Native Pl. Queensland 4: 244 (1999).

Sparse shrub to 1 m tall; young branches with scarcely raised leaf bases but flanges clearly demarcated by recessed lateral margins, glabrous except rarely with scattered short hairs or papillae between the flanges; early bark mainly splitting into long longitudinal membranous flakes, but soon becoming thick and corky. *Leaves* alternate; *petiole* 0–0.2 mm long, appressed, later spreading; *lamina* linear to linear-elliptic, 11.6–17.3 × 0.9–1.3 mm, acute, gradually tapering into a

petiole, erect-spreading, above flat to slightly concave, below ± convex, with many fine oil glands extending to the margins, glabrous. *Inflorescence* a rounded to flat-topped botryum with 5–9 flowers, apparently terminal on all branches, with terminal vegetative growth after fruiting; *retained perules* 2–5, ovate-triangular, 2–2.5 mm long, obtuse to pointed, (1–) 3-veined, glabrous, rarely with marginal hair at the apex; *bracts* ovate, 10–12.3 × 0.4–0.6 mm, acute, 1 (–3)-veined, glabrous, leaf-like, upper ones or all caducous (not seen); *bracteoles* caducous (not seen but scars present). *Hypanthium* 3.9–4.2 mm long when flowering (free tube c. 2 mm long), obconical, glabrous. *Calyx lobes* triangular, 1.4–1.6 mm long, pointed, glabrous. *Corolla lobes* compressed obovate-orbicular, c. 4 mm long (immature), white. *Stamens* more than 50 in more than one whorl; *filaments* 1.1–2.7 mm long (immature), centrifugal ones almost twice as long as centripetal ones, but unknown whether both are erect; *anthers* ellipsoidal, c. 0.4–0.45 mm long, with subterminal gland. *Ovary* 3-locular, with style base somewhat sunk into the glabrous upper surface; *placenta* a broadly elliptic disc with a short central attachment, scarcely lobed, each lobe with 3 (4) rows of ovules; *ovules* 18–22 per locule, spreading to pendulous with lower ones slightly longer; *style* c. 8 mm long after flowering, with stigma flat-capitate with depression in the middle. *Fruit* and *seeds* not seen. *Flowering*: August. **Fig. 19.**

*Distribution and ecology*. Known only from the type locality where it has been recorded from "cracks in rocks along creek", near Herbert River, Queensland (NK).

*Conservation status.* R.J. Cumming commented on the type collection: "Uncommon, about thirty plants present in a very small area" of Yamanie National Park so that it listed as Endangered in Queensland (Bostock & Holland 2015).

*Diagnostic features.* Although *K. truncata* resembles in its irregular branching other species in sect. *Platyphyllae*, especially the very similar *K. graniticola*, it differs by having long and short stamens, which it shares with *K. petrophila*. Those two are, however, obviously distinct because the branches and flowers of *K. petrophila* are hirsute to woolly, while plants of *K. truncata* are glabrous. The latter species has also, unlike other species of sect. *Platyphyllae*, truncate mature flower buds, normally only found in species of sect. *Niviferae*, which in turn also have elongate inflorescences with terminal leaves and a regular growth pattern with short shoots at all nodes of distal branches.

*Etymology*. Although *K. truncata* is similar to other species in this section, the unusual presence of its flat-topped flower buds earned it the epithet "truncata", Latin, "truncate, ending very abruptly as if cut straight across".

**46. *Kunzea petrophila* Toelken, *sp. nov.***

*A speciebus aliis sectionis* Platyphyllarum *ramis principalibus distalibus brachyblasto vegetativo in quoque nodo, tomento hirsuto vel lanato in ramis et hypanthiis; a speciebus sectionis* Pallidiflorarum *tomento hirsuto vel lanato in ramis et hypanthiis, bracteis et bracteolis brevis chartaceis deciduis differt.*

**Type:** Northern Territory, along Keep River, c. 30 km E Kunanurra, *P.A.Fryxell, L.A.Craven & J.McD. Stewart 4868*, 20.vi.1985 (holo.: CANB377035; iso.: BRI415817, NSW; G, n.v. ).

*Kunzea sp. (Keep River; Sivertsen 739)* J.D.Briggs & J.H. Leigh, Rare Threat. Austral. Pl. 117 (1996).

*Kunzea sp. M* de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

Spreading or decumbent shrub up to 2 m tall; young branches with scarcely raised leaf bases and flanges ± visible, hirsute to woolly, rarely pubescent with ± spreading fine antrorse hairs; early bark splitting into longitudinal strips, ± corky but usually with membranous margins. *Leaves* alternate; *petiole* absent; *lamina* linear-lanceolate to linear-oblanceolate, 6–9.5 (–11) × 0.9–1.2 mm, pointed, gradually tapering into the base, erect-spreading, flat to slightly concave above, slightly convex below and with at least one vein visible, hirsute to pubescent or sericeous with spreading to appressed fine antrorse hairs, rarely glabrescent. *Inflorescence* either apparently terminal usually on main branches forming elongate to almost globular botrya with 10–18 sessile flowers without terminal growth and not subtended by additional inflorescences on axillary short shoots; or on short shoots developing elongate botrya with (3–) 5–16 (–24) sessile flowers and frequently continuing into terminal vegetative growth and subtended by few globular inflorescences (2–5 flowers); *retained perules* (2–) 5–8, linear-lanceolate to linear-elliptic or ovate, 1.9–5 mm long, acute to pointed, usually 1-veined, hirsute to woolly, chartaceous to leaf-like; *bracts* broadly ovate becoming ± pointed on upper flowers, sometimes leaf-like but with ± broadened base, 3.6–4 × 2.8–3.4 mm, acute to acuminate, usually 3-veined, hirsute to woolly outside, with few long antrorse hairs also on the inside, deciduous, rarely leaf-like and persistent towards the apex of the inflorescence; *bracteoles* in pairs, ovate to lanceolate, 3–3.3 × 1.2–2 mm, acute to acuminate, 3–5 (–7)-veined, hirsute outside, with few to many long antrorse hairs also on the inside, deciduous. *Hypanthium* 2.8–3 mm long when flowering (free tube 1.2–1.6 mm long), cup-shaped, hirsute. *Calyx lobes* triangular, 1–1.4 mm long, pointed, pubescent to hirsute with antrorse hairs on outside and appressed hairs on the inside. *Corolla lobes* obovate-orbicular, 1–1.3 mm long, minutely ciliate, cream. *Stamens* 40–46 in more than one whorl; *filaments* 0.6–1.3 mm long, antepetalous ones about twice longer than antesepalous ones; *anther* 0.3–0.4 mm long, recurving, with distinct subterminal gland. *Ovary* 3-locular, with narrow style base somewhat sunk into the upper surface; *placenta* a broadly elliptic disc with short central attachment, scarcely bilobed,

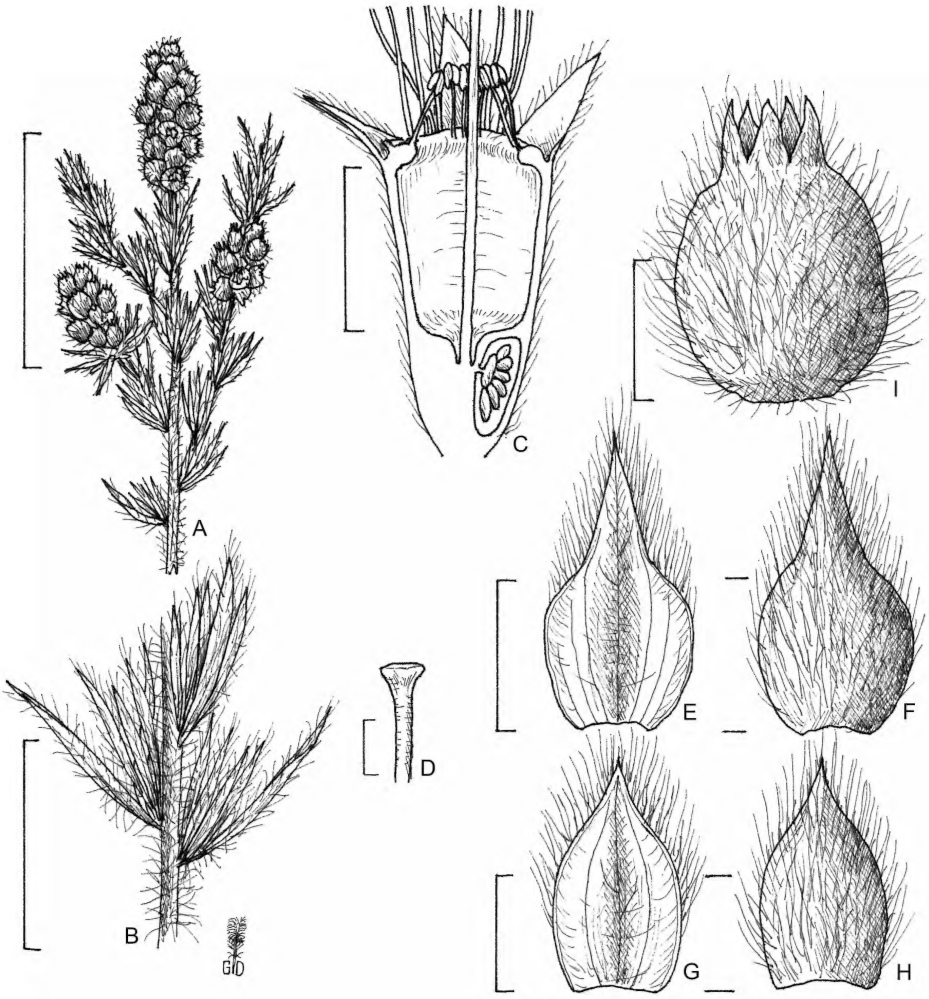


**Fig. 20.** ***K. petrophila***: **A** fruiting branch; **B** short shoots in axils of cauline leaves; **C** half flower with long and short stamens; **D** ± funnel-shaped stigma; **E** adaxial view of distal bract; **F** abaxial view of distal bract; **G** adaxial view of bracteole; **H** abaxial view of bracteole; **I** fruit. — Scale bars: **A** 4 cm; **B** 1 cm; **C** 1 mm; **D** 0.5 mm; **E, F, I** 2mm; **G, H** 1.25 mm. — **A–I** *P.A.Fryxell et al. 4868* (CANB).

with each lobe bearing 4 rows of ovules; *ovules* 45–51 per locule, subequal, spreading; *style* 5.8–6.4 mm long, with stigma broadened, somewhat compressed at apex. *Fruit* an urceolate capsule with erect calyx lobes. *Seeds* irregularly angular cylindrical, ± curved, finely vertically ribbed with few oblique connections. *Flowering*: On four specimens collected in June there were mainly old fruit. **Fig. 20.**

*Distribution and ecology.* Found on sand in sheltered crevices on sandstone cliffs along the Keep River, Northern Territory (VR).

*Conservation status*. Recorded as locally common on sandstone cliffs in the Keep River National Park; listed as Near Threatened in the Northern Territory (N.T. Herbarium 2015–). (2RC in Briggs & Leigh 1996).

*Diagnostic features. Kunzea petrophila* is similar to species of sect. *Platyphyllae*, as it has globular to sometimes elongate inflorescences with deciduous broad chartaceous bracts, but is distinguished by its regular growth habit with short shoots in the axils of all leaves on the distal main branches. The latter characteristic is typical of the sections *Pallidiflorae* and *Niviferae*, but this species is distinguished from species of both these sections by its hirsute to almost woolly (curled

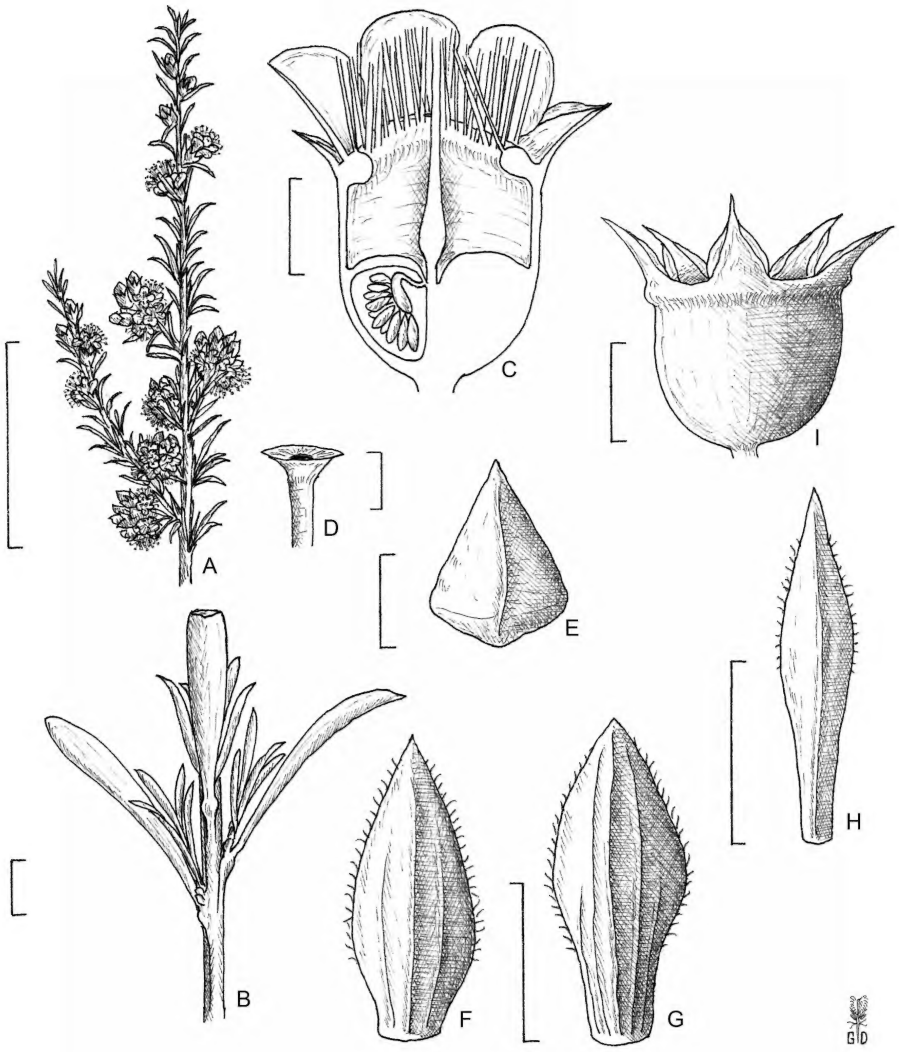


**Fig. 21.** ***K. occidentalis***: **A** flowering branch; **B** short shoots in axils of cauline leaves; **C** half flower; **D** funnel-shaped stigma; **E** abaxial view of perule; **F** abaxial view of proximal bract; **G** abaxial view of distal bract; **H** abaxial view of bracteole; **I** fruit. — Scale bars: **A** 5 cm; **B, F, G, I** 1.5 mm; **C, H** 1 mm; **D, E** 0.25 mm. — **A–D** *G.J.Harden NE38781*; **E–H** *C.W.Frazier NE37032*; **I** *D.F.Mackay NE42326*.

or twisted) tomentum on branches and flowers. The species is, however, unusual to both these sections because it produces stamens of two sizes (not in sect. *Pallidiflorae*), and they are unlike those of flowers of species of sect. *Niviferae*, as none of the shorter stamens remain incurved, and because the apex of mature flower buds is not truncate but acute-conical in *K. petrophila*. Furthermore it differs from sect. *Niviferae* by its sessile flowers in dense inflorescences with or without terminal leaves, and bracts and bracteoles are usually broad-based and scale-like chartaceous. The species is placed into sect. *Platyphyllae* based on molecular evidence. *Kunzea petrophila* is an unusual species as it shares the feature of hairs on the inside of the calyx lobes only with *K. baxteri*; it also grows well out of the mainly temperate to subtropical range of the genus.

A recent collection from western Queensland, which vegetatively resembles this species, might be *K. petrophila*, but could not be examined in detail.

*Variation*. Young leaves are usually covered with long

fine hairs, but these often become more appressed to sericeous; they are often glabrescent as the hairs on leaves wear off easily. The characteristic hirsute to woolly tomentum of the species applies mainly to the branches and flowers.

In younger flowers the hypanthium is often more obconical as in the very similar *K. truncata*, but in the fruiting stage they are typically cup-shaped.

*Etymology.* As the species is recorded as locally common on sandstone cliffs the epithet "petro-phila", Greek, "rock-loving" seems appropriate.

*Specimens examined*

Northern Territory: *I.D.Cowie 7720*, Keep River N.P., 31.v.1998 (DNA); *J.L.Egan 5047*, Gurrandalng area, 9.vi.1995 (AD, DNA); *J.L.Egan 5051*, Keep River, Gurrandalng area, 9.vi.1995 (AD, DNA); *J.L.Egan 5100 & A.Bowlay*, Keep River, S Jarrnara, 16.vi.1995 (AD, DNA, MEL).

## D.2. *Kunzea* sect. *Pallidiflorae* Toelken & de Lange

in de Lange et al., Austral. Syst. Bot. 23: 317 (2010). — **Type species:** *K. ambigua* (Sm.) Druce.

*Kunzea* sect. '*Eukunzea*' Benth., Fl. Austral. 3: 112 (1867), nom. inval., pro parte, quoad *K. corifolia* (synomym of *K. ambigua*).

Distal main branches with vegetative short shoots at each node shorter than or as long as subtending leaf; leaf bases becoming flanges. *Inflorescence* spiciform to racemiform in *K. axillaris*, without terminal leaves, except sometimes in *K. axillaris*; mature flower buds pointed with erect, usually unequal calyx lobes; bracts and bracteoles scale-like and deciduous; petals white; *stamens* subequal, erect, longer than petals and about as long as the style.

*Discussion*. The three species included in this section resemble species of sect. *Niviferae* closely, because, for instance, the distal branches develop short shoots in the axils of all leaves and only some of these will continue growing in the next year; their decurrent leaf bases are more or less flanged and bracts and bracteoles are scale-like. They are, however, easily distinguished by their acute mature buds and erect long styles.

While the inflorescences of *K. ambigua* and *K. occidentalis* have sessile or subsessile flowers and usually continue terminal growth only after fruiting, flowers of *K. axillaris* are stalked and always develop from the beginning some leaves above the flowers, which is similar to species in sect. *Niviferae*.

### 47. *Kunzea occidentalis* Toelken, *sp. nov.*

Kunzeae ambiguae *similis sed folia (16–) 20–40 (–48) glandulibus in paginis abaxialibus, foliorum basibus albidis spongiosis in ramis junioribus et fructibus > 3.2 mm in diametro differt.*

**Type:** New South Wales, Waa Gorge, Mt Kaputar National Park, *R.Coveny 9030 & S.K.Roy*, 2.xi.1976 (holo.: NSW; iso.: K, L, n.v.).

*Kunzea aff. ambigua* auct. non (Sm.) Druce: N.C.W.Beadle, Student Fl. N.E. New South Wales 3: 477 (1976).

*Kunzea sp. D* Joy Thomps. in S.W.L.Jacobs & Pickard (eds), Pl. New South Wales 166 (1981); Peter G.Wilson in G.J. Harden (ed.), Fl. New South Wales 2: 154 (1991); de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

*Kunzea sp. Mt Kaputar (E.N.S.Jackson 2246)* Peter G. Wilson in G.J.Harden (ed.), Fl. New South Wales, ed. 2, 2: 177 (2002).

Spreading shrubs 1.2–2.5 m, rarely up to 6 m tall; young branches with raised leaf bases in the form of decurrent flanges of cream spongy tissue, puberulous, rarely pubescent with short and a few longer hairs but usually soon becoming glabrous; early bark repeatedly splitting longitudinally into long irregular strips, becoming corky and usually not peeling. *Leaves* alternate; *petiole* 0–0.7 (–1.2) mm long, appressed, but with at least apex ± spreading; *lamina* narrowly elliptic-oblanceolate to linear-elliptic, (2.6–) 4–6.5 (–8.4) × 0.75–1 (–1.3) mm, obtuse to rounded, rarely acute, gradually tapering into petiole, straight and ± recurved from the upper petiole, above concave to ± folded lengthwise, usually convex below and with (16–) 20–40 (–48) glands irregularly arranged, puberulous to glabrescent and usually with appressed marginal hairs. *Inflorescence* a slightly elongate to globose botryum with (1–) 3–6 (–8) flowers, with "pedicel" 0.2–0.4 mm long, apparently terminal on long shoots and with similar or more abbreviated ones on lateral short shoots below them, usually without terminal vegetative growth when flowering; *retained perules* triangular to oblong-triangular, 0.15–0.5 mm, often acute, puberulous to glabrescent with marginal cilia; *bracts* ovate-elliptic to oblanceolate-elliptic on upper flowers, 1.7–2.2 × c. 1 mm, acute to obtuse, 3 (–5)-veined, fleshy with narrow hyaline margins, usually glabrous except for marginal cilia, deciduous; *bracteoles* in pairs, linear-oblanceolate to -spathulate, rarely obliquely so, 1.8–2 × 0.4–0.7 mm, acute, with pronounced central ridge and hyaline margins, glabrous except for some marginal cilia, caducous. *Hypanthium* 3.2–4.1 mm long when flowering (free tube c. 1.8 mm long), not ridged, glabrous to rarely pubescent. *Calyx lobes* ovate-triangular but often appear linear-triangular because of incurved margins, 1.1–1.5 mm long, acute to pointed, scarcely ridged, glabrous, rarely puberulous. *Corolla lobes* broadly obovate to almost orbicular, 1.9–3.1 mm long, often erose, white. *Stamens* 48–60 in more than one whorl; *filaments* 2–4.8 mm long, often unequally long; *anthers* with large subterminal gland. *Ovary* 3 or 4-locular, with style distinctly sunk into the upper surface; *placenta* a fleshy elliptic disc with short apical attachment, scarcely divided into 2 lobes, each with 4 rows of ovules; *ovules* 49–58 per locule, spreading but ± curved downwards; *style* 3.8–5.6 mm long, with stigma usually a scarcely broadened thick disc with central depression. *Fruit* a cup-shaped capsule, 2.9–3.5 × 3.2–3.8 mm, often broader than long, with erect calyx lobes slightly recurving towards the apex. *Seeds* irregular-angularly pyramidal to -cylindrical, ± curved, vertically scalariform-ribbed. *Flowering*: October, November. **Fig. 21.**

*Distribution and ecology.* Found on rocky slopes or often on ridges usually in heath or scrub with scattered eucalypts on mainly western slopes of the Great Divide in New South Wales (NWS, CWS, NWP).

*Conservation status*. Locally common and conserved in, for instance, Warrumbungle and Mt Kaputar National Park.

*Diagnostic features. Kunzea occidentalis* is very similar to *K. ambigua* and isolated populations have different distinguishing features or combination of characters. However, the number of usually dark glands on the abaxial leaf surface of leaves is (16–) 20–40 (–48) as opposed to more than 50 in *K. ambigua*. If these glands include distinctly smaller ones then they will be in groups of (1–) 3 (–5), or in a row closest to the leaf margins in *K. ambigua*. Similar numbers of glands were observed on longer and straight leaves, comparable to those of *K. ambigua*.

Commonly, the pale cream shiny flanges of the branches develop a white spongy tissue and are well visible, because they are more or less glabrous, except for some very short hairs. Young branches of *K. ambigua* sometimes also become silvery-grey when they are slightly older, but then the flanges are already more or less split and scarcely recognisable. None of these flanges also develop the spongy tissue typical of *K. occidentalis*. The typical densely hairy branches of *K. ambigua* are observed particularly higher up on the same or other actively growing branches of that species. Although the central axis of the inflorescence of *K. occidentalis* is more or less densely hairy and this tomentum often only gradually decreases below the inflorescences, young branches of this species cannot be confused with those of *K. ambigua,* because they are glabrescent.

In addition, fruits of *K. occidentalis*, if present, are usually broader than 3.2 mm, but immature material may be intermediate, e.g. *J.R.Hoskins 173*. The apex of the leaves tends to be obtuse to rounded. Inflorescences, particularly the lateral ones on short shoots, tend to be short and more or less globular, and the terminal inflorescences with flowers in the axil of leaf-like bracts have rarely more than seven flowers in comparison to the commonly much longer ones found in *K. ambigua*.

*Variation*. *Kunzea occidentalis* is a remarkably uniform species considering its wide, often disjunct distribution. Separate populations with usually individual characteristics occur often in widely separated localities mainly on the western slopes of the Great Divide. The most obvious variant is a densely hairy form recorded from the northern Nandewar Ranges. Another one from the Hunter Valley (e.g. *Hoskings 173*), has more delicate branches similar to *K. ambigua* and is described as a tree up to 6 m tall. The corky bark and very obtuse leaf apices suggest, however, that it is *K. occidentalis*.

The development of the inflorescences on distal main branches varies considerably. The inflorescences, apparently terminal to main branches, are usually, unlike those of *K. ambigua*, short and more or less rounded and at times reduced to a few flowers. Rarely, the distal inflorescence is not at all developed and in those cases, the lateral inflorescences on short shoots have only 1–3 flowers. However, if this is the case, many short shoots develop, each with few-flowered inflorescences (e.g. *C.W.Frazier NE37032*).

*Etymology*. While most species of *Kunzea* in eastern Australia are found on or on the eastern side of the Great Divide this species occurs on rocky outcrops mainly west of the mountains. The epithet, "occidentalis", Latin, "western" refers to its more western distribution, particularly in comparison to the very similar *K. ambigua*.

*Selection of specimens examined (44 examined)*

New South Wales: *L.Abrahams 472,* Cobar district, x.1910 (NSW); *D.F.Blaxall 679*, Rays Ck, c. 14 km E "Gidgiegolambo", 76 km N Cobar C.P., 15.xi.1971 (NSW); *B.G. Briggs 6234 & L.A.S.Johnson*, SE slopes of Siding Spring Mtn, 9.xi.1975 (NSW); *E.F.Constable 4546*, Mulgoven Stn, top of Gunderbooka Ra., 35 mls [56 km] S Bourke, 16.x.1963 (BRI, NSW); *M.D.Crisp 3615*, Burrumbuckle Rock, 8.xi.1977 (CANB); *J.M.Curran MEL92796*, Cobar, 1887 (MEL); *J.W. Dwyer NSW124216*, Trungley Rd near Barmedman, iv.1914 (NSW); *C.W.Frazier NE37035*, Mt Kaputar, 1.x.1961 (NE); *G.J.Harden NE38781*, Warrumbungle, 26.x.1974 (NE); *J.R.Hosking 173*, between Hollydeen and Sandy Hollow, 10.x.1985 (NSW); *E.N.S.Jackson 2246*, Mt Kaputar, 30.x.1972 (AD); *L.A.S.Johnson & E.F.Constable NSW20489*, Tooraweenah Ck, Warrumbungle Ra., 18.iv.1952 (NSW); *R.Johnstone 1774 & A.E.Orme*, summit of Mt Woorut, 12.i.2006 (NSW); *A.M.Lyne 189*, 11 km W Mt Kaputar, 27.ix.1990 (AD, CANB); *A.M.Lyne 1302 & J.Lyne*, walking track to the Governor, Nandewar Ra., 8.iii.1994 (AD, CANB, NSW); *D.F.Mackay NE42326A*, Hawks Nest Cliffs, Deriah S.F., 12.ii.1985 (NE); *R.O.Makinson 1250 & B.Harrison*, on Nuada Saddle, Warrumbungle Ra., 30.xi.1992 (AD, CANB); *A.Mitchell NSW124220*, Buggajool Forest, Barmedman, vi.1974 (NSW); *B.Muffet CBG53091*, 34 km from Narrabri on Mt Kaputar Rd, 24.viii.1973 (CANB); *W.E.Mulham W1003*, near Yathong, vi.1977 (NSW); *M.E.Phillips CBG22569*, between Camp Pincham & Camp Wimbelong, Warrumbungle Ra., 28.viii.1961 (CANB); *R.W.Purdie 6862*, Mary Gilmore Way, E Barmedman, 7.x.2008 (CANB, NSW); *R.Story 6762*, Giants Ck, 2 mls [3.2 km] NW Sandy Hollow, 6.x.1959 (CANB); *H.Streimann 621*, Mt Woonut, Warrumbungle Ra., 7.xii.1973 (CANB; A, K, L, n. v.); *E.H.F.Swain 40*, Terrengee, N Nandewar Ra., xi.1914 (NSW); *J.T.Waterhouse NSW 124222*, Siding Spring Mt, Mt Woonut, 9.xi.1962 (NSW); *T. Werner NSW124231*, "Yathong", 30 mls [48.6 km] NNE Roto, 29.x.1969 (NSW); *J.B.Williams NE32812*, Canyon Camp, Warrumbungle Ra., 30.x.1971 (NE); *P.G.Wilson 1478 & W. Cherry*, Mt Grenfell, 13.i.2000 (AD, NSW).

*Putative hybrids*

**(i) *K. occidentalis* × *K. opposita***

At first sight the specimen appears to represent a depauperate branch of *K. occidentalis*, because of its cream young branches with some flanges on long shoots, but they are not as clearly developed as in that species. Characteristic typical of that species are also the narrow erect, and usually unequally long calyx lobes

in the bud. The upper leaves are linear, scarcely fleshy and folded lengthwise as in *K. occidentalis*, but all leaves are unusually short ((2.2–) 3–4 (–4.8) mm long), subsessile and upper leaves are often subopposite to opposite, similar to those of *K. opposita*. Lower leaves on long shoots tend to be linear-lanceolate, the many inflorescences are few-flowered and rounded and with deciduous bracts as in *K. opposita*.

No open flowers were available to test pollen sterility or whether the dominance of pink petals, as shown in the hybrid, would be enough to confirm that it is not a hybrid with *K. parvifolia*. This hybrid of *K. opposita*, though very similar, is distinguished from the latter by its lanceolate leaves without subterminal point.

*Specimen examined*

New South Wales: *G.J.Harden NE38940*, Yalludunida Crater, Mt Kaputar N.P., 10.xi.1976 (NE).

*Putative parents from the general area*

***K. occidentalis.*** New South Wales: *A.M.Lyne 189*, 11 km W Mt Kaputar, 27.ix.1990 (AD, CANB); *A.M.Lyne 1302 & J. Lyne*, walking track to the Governor, Nandewar Ra., 8.iii. 1994 (AD, CANB, NSW).

***K. opposita.*** New South Wales: *G.J.Harden NE38941*, Yalludunida Crater, Mt Kaputar N.P., 10.xi.1976 (NE).

**(ii) *K. occidentalis* × *K. parvifolia* A**

One immediately associates this hybrid with *K. occidentalis*, because of its similar erect habit, cream young branches, as well as most of the leaves being erect and having a terminal point, while only a few of them show the subterminal bulge typical of *K. parvifolia*. In addition, the branching in growth flushes, the absence of not clearly demarcated flanges, the presence of scale-like chartaceous deciduous bracts and bracteoles as well as pink flowers are reminiscent of *K. parvifolia*.

*Specimens examined*

New South Wales: *G.W.Althofer MEL92482*, Warrumbungle Ra., 6.x.1946 (MEL: pollen sterility 26%, NSW 124224).

*Putative parents from the general area*

***K. occidentalis.*** New South Wales: *G.W.Althofer MEL 92490*, Warrumbungle Ra., 6.x.1946 (MEL: pollen sterility 1%, NSW124226).

***K. parvifolia.*** New South Wales: *B.G.Briggs 914*, 2 mls [3.2 km] W Timor Rock, Warrumbungles, 24.x.1966 (NSW).

**(iii) *K. occidentalis* × *K. parvifolia* B**

Two pairs of specimens have been recorded of white to pink-flowered forms growing between the normally purple-flowered *K. parvifolia* on the road between Junee and Cootamundra. These plants resemble that species in its habit with irregular growth flushes, the absence of flanges, small linear leaves with subterminal point, and small globose inflorescences each with few flowers and each ovary with five locules, but the leaves are longer ((3.6–) 4–5 mm long), the lateral branches are short and the solitary inflorescence as well as the caducous bracts and pale pink flowers are reminiscent of *K. occidentalis*. The high percentage of sterile pollen and the fact that many of these grains are malformed also indicate their hybrid nature. However, the latter species has not yet been recorded from the same area, though occurs in an area just north of it. This and the more delicate habit of these plants might indicate that in this case *K. parvifolia* was the maternal parent, while in *K. occidentalis* × *K. parvifolia* A it was *K. occidentalis*.

*Specimens examined*

New South Wales: *D.W.Shoobridge CBG23504*, 22 mls [35.2 km] Junee to Cootamundra, 11.xi.1966 (CANB) (pollen sterility 76%); *A.Mitchell NSW147311* (pollen sterility 38%) *& A.Mitchell NSW147312* (pollen sterility 48%), 11 mls [17.6 km] Cootamundra to Junee, xi.1962, (NSW).

*Putative parents from the area*

***K. parvifolia.*** New South Wales: *D.W.Shoobridge CBG 23503,* 22 mls [35.2 km] Junee to Cootamundra, 11.xi.1966 (CANB) (pollen sterility 2%); *A.Mitchell NSW147310*, 11 mls [17.6 km] Cootamundra to Junee, xi.1962, (NSW) (pollen sterility 9%).

***K. occidentalis.*** New South Wales: *J.W.Dwyer NSW 124219*, Temora, x.1913 (NSW).

### 48. *Kunzea ambigua* (Sm.) Druce

Bot. Exch. Club Soc. Brit. Isles Rep. 1916, Suppl. 2: 629 (1917); Snelling, Bot. Mag. 150, t. 9032 (1924); Ewart, Fl. Victoria 865 (1931), pro parte; W.A.Curtis, Student Fl. Tasmania 199 (1956); N.C.W.Beadle et al., Handb. Vasc. Pl. Sydney District 291 (1963); Cockrane et al., Fl. & Pl. Victoria t. 207 (1968); N.T.Burb., Fl. Austral. Cap. Territory fig. 266 (1970); J.H.Willis, Handb. Pl. Victoria 2: 450 (1973), pro parte; W.A.Curtis, Student Fl. Tasmania, ed. 2, 1: 202 (1975); Joy Thomps. in S.W.L.Jacobs & Pickard (eds), Pl. New South Wales 166 (1981); Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales 2: 153 (1991); Jeanes in N.G.Walsh & Entwisle (eds.), Fl. Victoria 3: 1020 (1996); Pellow et al., Fl. Sydney Region, ed. 5, 202 (2009). — *Leptospermum ambiguum* Sm., Trans. Linn. Soc. London 3: 264 (1797); Cheel, J. & Proc. Roy. Soc. New South Wales 76: 230 (1943). — **Type:** ex hort. G.Hibbert (holo.: LINN-HS878/19 on microfiche!; possible iso.: "Smith missit" in Herb. Ventenat in G00223382!; cf. Typification).

*Metrosideros corifolia* Vent., Jard. Malmaison 1: 46, pl. 46 (1804). — *Stenospermum corifolium* (Vent.) Sweet ex Heynh., Nomencl. Bot. Hort. 2: 787 (1841); Sweet, Hort. Brit., ed. 2, 209 (1830), nom. inval., 3 spp. sine descriptione generico. — *Kunzea corifolia* (Vent.) Heynh., Nomencl. Bot. Hort. 2: 338 (1841); Schauer in Lehm., Pl. Preiss. 1: 124 (1844); Benth., Fl. Austral. 3: 115 (1867). — **Type:** "Originaire de la Nouvelle Hollande", type specimen not located: lecto., designated here: Vent., Jard. Malmaison 1, pl. 46 (cf. Typification).

*Metrosideros abietina* Hoffmanns., Verz. Pfl.-Kult. 80 (1824), nom. nud. & inval. (*M. corifolia* in synonymy); Heynh., Nomencl. Bot. Hort. 1: 338 (1840), nom. inval. (in synonymy of *K. corifolia*).

*Kunzea pelagia* F.Muell. ex Miq., Ned. Kruidk. Arch. 4: 145 (1856). — **Type:** Tasmania, [*C.Stuart*, Schouten Is.] ex Herb. F.Mueller (lecto., designated here: U66215B; isolecto.: MEL92330; MEL92336; MEL92421; cf. Typification).

Spreading, rarely decumbent shrubs to erect trees, 1–2.5 (–4) m tall; young branches with slightly raised leaf bases in the form of decurrent flanges but ± obscured by tomentum, pubescent to hirsute with short and longer hairs usually spreading at about right angles; early bark repeatedly splitting longitudinally into irregular elongate pieces with peeling margins. *Leaves* alternate; *petiole* 0–0.8 mm long, appressed to ± spreading at least at the apex; *lamina* linear-elliptic to elliptic-oblanceolate, (3.7–) 5–10 (–12.6) × (0.5–) 0.7–1.4 (–1.9) mm, acute and slightly recurved, rarely obtuse, gradually tapering into petiole, straight and ± recurved from upper petiole, above flat becoming concave to cymbiform when dried, ± convex below and with (50–) 55–90 (–115) glands including rows of distinctly smaller ones lining the leaf margins, hirsute, pubescent or puberulous but commonly becoming glabrous with or without appressed marginal hairs. *Inflorescence* racemose (often with terminal vegetative growth), or globular (normally without terminal vegetative growth when flowering) botrya with (1–) 5–16 (–23) flowers, commonly with a "pedicel" 0–0.8 mm long, elongate ones distal on long shoot with elongate or globose ones on short shoots below them; *retained perules* 3–5, triangular to oblong-triangular, 0.5–0.8 mm, rarely leaf-like and longer, ± obtuse, pubescent, puberulous to glabrous except usually with marginal cilia; *bracts* leaf-like, lanceolate to oblong-elliptic on upper flowers, rarely to broadly ovate, (1.6–) 2–3 × 0.35–0.8 (–2.1) mm, obtuse or acute, 3-veined, usually glabrous except for marginal cilia and some hairs along the central vein, caducous to deciduous or rarely persistent mainly on upper flowers; *bracteoles* oblong-lanceolate to -elliptic, (0.8–) 1–2.5 (–3.1) × (0.2–) 0.3–0.6 (–0.8) mm, acute, 1-veined, glabrous except for some marginal cilia, caducous. *Hypanthium* (2.1–) 2.2–2.5 (–2.8) mm when flowering (free tube 1–1.5 mm long), 2–3.4 mm in diameter, cup-shaped, not ridged, pubescent or puberulous, rarely hirsute. *Calyx lobes* ovate-triangular to almost triangular, (0.9–) 1.3–2 (–2.3) mm long, usually unequally long, acute to pointed, scarcely ridged, glabrous, rarely pubescent. *Corolla lobes* broadly obovate to almost orbicular, (1.5–) 1.8–2.5 (–3.2) mm long, often erose, white. *Stamens* 45–73, in more than one whorl; *filaments* 3.8–6 mm long and often ± unequally long; *anthers* broadly ellipsoidal, 0.5–0.55 mm long, with large subterminal gland. *Ovary* 3 (4)-locular, with style base distinctly sunk into the upper surface; *placenta* a fleshy elliptic disc with short central attachment, scarcely divided into 2 lobes, each with 3 to 4 rows of ovules; *ovules* 34–52 (–70) per locule, subequal, spreading, but ± curved downwards; *style* up to 8.4 mm long when fruiting, with stigma often much broadened, disc- to funnel-shaped with distinct central depression. *Fruit* a cup-shaped capsule, 2.9–3.5 mm long, with ± recurved calyx lobes. *Seeds* irregularly cylindrical, ± curved, vertically scalariform-ribbed with few oblique connections. *Flowering*: (October) November–January, but flowers, mainly on proliferations, have been recorded throughout the year. *Common Names*: **Tick bush** (Beedle et al. 1963, Carolin & Tindale 1993, Wilson 1991); **white kunzea** (Ewart 1931, Willis 1973, Jeanes 1996). **Fig. 22.**

*Distribution and ecology.* Recorded often from a wide range of soils in sclerophyll forest, but also often recorded from rock outcrops in heath; individual plants are sometimes recorded from swampy areas. Occurs in New South Wales chiefly south of the Sydney area (CC, SC, CT, ST), Victoria (EG, GPL, PROM) and north-eastern Tasmania (FI, NE, EC) including many islands of the Bass Strait; marginally naturalised in South Australia (SL) and New Zealand.

*Conservation status.* A widespread species occurring locally common also in conserved areas.

*Diagnostic features*. While the very similar *K. occidentalis* (see also under its Diagnostic features) occurs mainly on the western slopes of the Great Divide, *K. ambigua* is found on the eastern slopes and especially on the coastal foothills. Athough not always visible on all leaves, the darker glands on the abaxial leaf surface tend to be smaller than those of *K. occidentalis*. They number (50–) 55–90 (–115) and usually a row of distinctly smaller glands lines the leaf margins. There is a gradual increase southward with the highest number of glands recorded from Wilsons Promontary and north-eastern Tasmania (e.g. St Helens, *T.E.Burns 195*). Numbers higher than 100 have also been recorded from the North Coast of New South Wales, but here the glands are much less clearly visible and often obscured by hairs. The pale cream spongy flanges and usually broader fruit (more than 3.2 mm), diagnostic of *K. occidentalis*, are not observed in *K. ambigua*, except for somewhat thicker fruit but of different texture on some specimens from Wilsons Promontory and northern Tasmania. Neither of these characters are found in *K. axillaris*. On specimens of *K. axillaris* the stalked flowers are in the axils of distal leaves, but, although they appear to be axillary, they bear caducous bracteoles (or usually only their scars are observed on each flower stalk). This shows that these are foliose botrya with very much elongated internodes obvious between flowers unlike the more compact inflorescences of *K. ambigua* and *K. occidentalis*. In addition, the central axis of the inflorescences of the latter two species is densely hairy in contrast to the glabrous branches of *K. axillaris*.

*Variation*. Much local variation has been recorded for *K. ambigua* with regards to its globose to cylindrical or even elongate inflorescences (e.g. *E.Gauba CBG7043*), but then only an occasional terminal inflorescence on main branches, while all the other inflorescences, especially lateral ones, are globose or almost so. The flowers may vary from hirsute, pilose to glabrous or with pilose hypanthium and glabrous calyx, but none of this variation could be linked with other characters. This species can, however, be more or less divided into

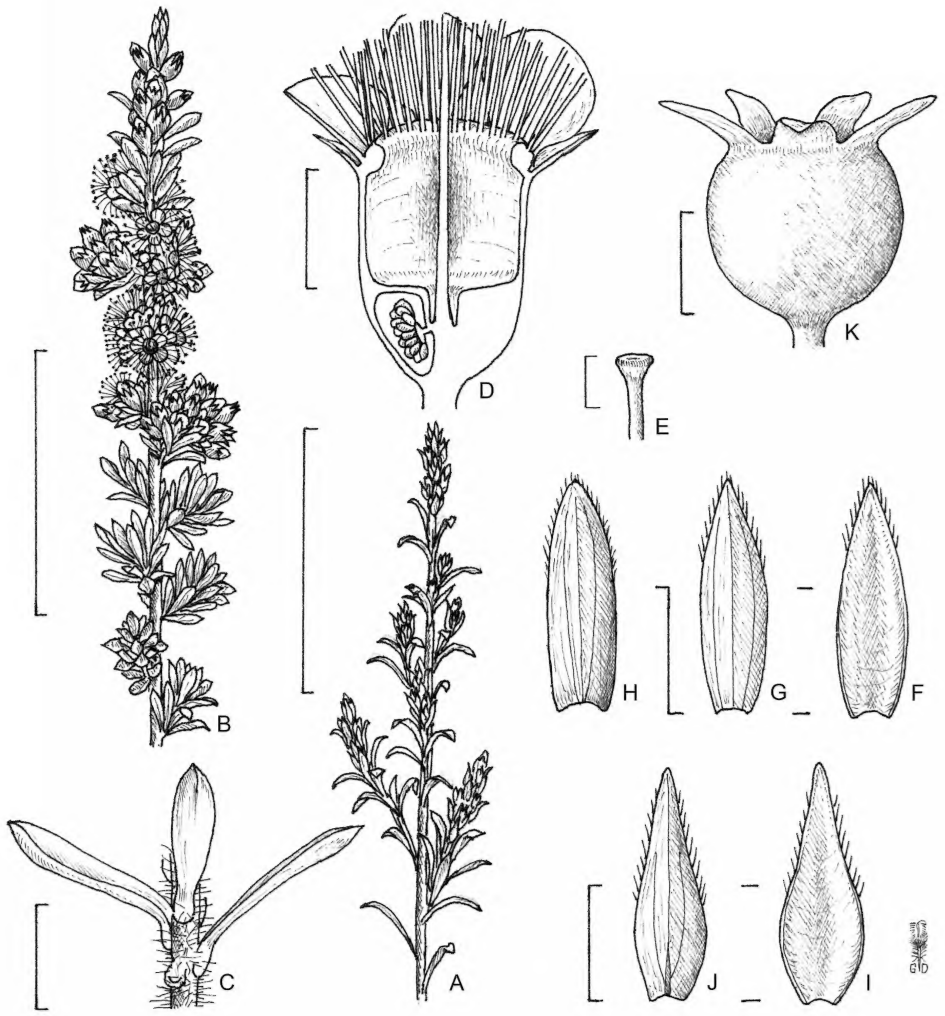


**Fig. 22.** ***K. ambigua***: **A** branch in bud showing bracts; **B** flowering branch; **C** cauline leaves; **D** half flower; **E** funnel-shaped stigma; **F** adaxial view of proximal bract; **G** abaxial view of proximal bract; **H** abaxial view of distal bract; **I** adaxial view of bracteole; **J** abaxial view of bracteole; **K** fruit. — Scale bars: **A** 4 cm; **B** 5 cm; **C** 4 mm; **D, K** 1.5 mm; **E** 0.5 mm; **F, G, H** 2 mm; **I, J** 2.5 mm. — **A** *H.R.Toelken 7860* (AD); **B–K** *H.R.Toelken 6852* (AD).

three major forms, but no clear infraspecific taxa could be delimited:

(1) The typical form occurs near Genoa, Victoria northwards to just north of Sydney, and can usually be distinguished by the rather loose arrangement of the more or less elongate inflorescences at the ends of major branches, and leaves which are usually narrower than 1 mm. The hypanthium is 2–2.2 mm in diameter, while the glabrous calyx lobes (rarely with a few hairs) are (1.3–) 1.5–2.3 mm long, pointed and usually without membranous margins.

To the south, both the second and third forms are represented by an array of different variants in several more or less geographically isolated populations, but all of them are usually recognisable by their wand-like distal compound inflorescences with the lower lateral inflorescences being more or less round and subsessile. The leaves are generally more than 1 mm broad.

(2) The second, at times very distinct form occurs in north-eastern Tasmania roughly between St Helens and Bicheno. The hypanthium is 2–2.3 mm in diameter, and its dense indumentum also covers the calyx lobes,

which are 1–1.3 mm long, rounded (as are leaves) and with narrow membranous margins. The bracts are very short and broad and sometimes broader than long. This form was described by Miquel (1856) as *K. pelagia*.

(3) Another form refers to plants from Wilsons Promontory and surrounding areas, which have a hypanthium 2.8–3.4 mm in diameter, the calyx lobes are usually glabrous, 1.5–2.2 mm long, pointed, commonly ridged and with narrow membranous margins becoming broader towards the base.

Additional forms recorded mainly from the islands in the Bass Strait, but also from mainland Tasmania, show a range of variation and their recombination of the characteristics of above forms rendered the three extremes indistinguishable, especially as there is no present evidence of direct hybridization.

*Typification.* A type of Ventenant's ***Metrosideros corifolia*** could not be located in G, where most of his specimens are now deposited (Stafleu & Cowan 1986, p. 700). The plate 46 is therefore selected as the lectotype.

A probable isotype specimen of ***K. ambigua***, which J.E.Smith sent to Ventenant (inscribed "Smith missit – in herb. Ventenant.") was examined and identified at G by the author.

Although the combination *Stenospermum corifolium* (Sm.) Sweet was effectively published, it is invalid, because the genus with the two species had not previously been described (Article 35.1, McNeill et al. 2012).

Miquel (1856) did not designate a holotype when he described ***K. pelagia***. As he did not cite a collector or locality for the specimen, it is obvious that he did not see the duplicate specimens now in MEL. The specimen in U is therefore lectotypified and three similar specimens in MEL are accepted as duplicates (isotypes). Firstly, MEL92421, a fragment inscribed "ex Herb MEL" also refers to C. Stuart, who apparently collected the type, even though this was not mentioned in the protologue. Secondly, MEL 92330, which gives the locality of this restricted form as: "This sp. given me from Schouten Island East Coast of VDL", and it seems that this part of the label could have been written by C. Stuart, who collected in Tasmania between 1842 to 1857 and sent much of his material to F. Mueller (Buchanan 1990). The third specimen with no provenance (MEL92336) has a label in F.Mueller's handwriting, which merely states: "This does not agree with the description of *M. coriifolia* in G.Don in the calyx hairy tomentose in this specimen. It is there described as smoothish, but is nevertheless the same plant." Since Mueller considered it to be the same species, it could be assumed that his statement on the specimen could have influenced Bentham (1867), who had examined the latter two specimens and merely subsumed *K. pelagia* under *K. corifolia*.

*Selection of specimens examined (c. 150 seen)*

New South Wales: *W.F.Blakely NSW124166*, Kendalls Glen, Gosford, 16.x.1926 (NSW); *J.L.Boorman & E.Cheel NSW124169*, Bents Basin, Nepean River, ix.1913 (NSW); *A.K.Brooks 28*, 3.5 km S Helensburg, 21.vi.1988 (AD, NSW); *L.Carne NSW124203*, Lawson, xi.1908 (NSW); *E.F.Constable 4326*, Narrabarba, W Disaster Bay, 14.viii.1963 (NSW); *R.Coveny 3389*, Picton Lakes, 5 mls [8 km] SW Picton, 1.xii.1970 (NSW); *L.A.Craven 669*, 4 mls [6.4 km] NE Nerriga, 24.xi.1965 (NSW, CANB; B, BH, CHR, G, K, L, US, n.v.); *N.C.Ford NSW124172*, Newport, 15.viii.1945 (NSW); *E.Gauba CBG7043*, Pigeon House Ra., 9.i.1952 (BRI, CANB, NE); *R.D.Hoogland 11698*, Tianjara Falls, 26.xi.1969 (CANB, NSW; A, K. L, n.v.); *L.A.S.Johnson NSW124134*, 2 mls [3.2 km] E Leumeah, 6.xi.1948 (NSW); *E.J.McBarron 8553*, Veterinary Research Stn, Glenfield, 30.xi.1963 (NSW); *K.McDougall 717*, beside Green Cape Rd near junction with Bull Ck Forest Rd, 9.xii.1999 (CANB); *D.McGillivray 662*, Ulladulla, 31.x.1957 (NSW); *A.M.Lyne 1474*, Mt Imlay, i.ix.1994 (CANB); *A.M.Lyne 1553*, Tallong, 11.i.1995 (AD, CANB); *J.H.Maiden NSW124171*, Greenbrook, xi.1914 (NSW); *R.Melville & N.Wakefield 2903*, upper Genoa River, 15.i.1953 (MEL); *R.Pullen 4193*, near Nelligen Bridge, E of Clyde River, 22.xi.1966 (CANB, NSW); *F.A.Rodway NSW 124193*, Kangaroo Valley, 28.xi.1929 (NSW); *F.W.Sieber 324*, Nov. Holl., s.dat. (MEL); *J.R.Telford 3602*, Jingera Rock, Egan Pk, 8 km SSE Wyndham, 29.x.1973 (CANB).

Victoria: *B.J.Conn 2710 & J.L.Porter*, 25.8 km S Bendoc on Bonang Hwy, 12.xii.1987 (CANB, NSW); *L.A.S.Johnson NSW124215*, Tidal River, Wilsons Promontory, 13.i.1967 (NSW); *A.H.S.Lucas NSW124213*, Wilsons Promontory, i.1885 (NSW); *K.Macfarlane 255*, W end of Mt Oberon car park 11.xii.1996 (AD, CANB); *F.Mueller MEL92474*, Genoa River, ix.1860 (MEL); *MEL92335 & 92477*, granite near shores of Corner inlet, v.1853 (MEL); *B.Nordenstam & A.Anderberg 1203*, 8 km S Fish Ck towards Wilson Promontory, 11.xi.1989 (AD); *M.E.Phillips CBG21131*, Squeaky Bay to Leonard Pt, Wilsons Promontory, 21.xi.1961 (CANB, NE); *C.Walters NSW124212*, Gippsland, xi.1897 (NSW).

Tasmania: *M.I.H.Brooker 5886*, Mt Strzelecki walking track, Flinders Is., 12.vi.1978 (CANB, HO, NSW); *N.T. Burbidge 3064*, between Branxholm & Derby, 10.i.1949 (CANB, HO); *T.E.Burns 195*, St Helens, 24.xii.1959 (NSW); *R.C.Gunn 488/1842,* Allott, 18.xi.1842 (NSW); *J.H.Hemsley 6565*, Cape Mistaken, Maria Is., 1.ii.1969 (HO, NSW); *R.Johnston MEL92479*, Kings Is. (MEL); *C.E.Lord CANB7074*, Lady Barron Is., xii.1928 (CANB); *E.Maclaine MEL92496*, Clarks Is., 1889 (MEL); *J.Milligan 1165*, Bicheno, (HO, MEL); *M.E.Phillips CBG36943*, 2 mls [3.2 km] from Herrick to Moorina, 7.xii.1965 (CANB); *F.A.Rodway 2647*, Freycinet Penin., xii.1937 (NSW); *A.Smith MEL92495*, Mt Munro, 1891 (MEL); *J.S.Whinray 897*, Woody Is., 28.viii.1975 (AD); *J.S.Whinray 8985*, Cape Barren Is., s.dat. (AD, CANB; HO, NSW, n.v.); *J.S.Whinray 9394*, Flinders Is. S.F., Saddle at Head of Badger Gully, 7.i.1991 (AD, CANB; NSW, HO, n.v.); *C.Wilhelmi MEL92478*, Glenny Tasmania Islands (MEL).

South Australia: *C.J.Brodie 3884 & P.J.Lang*, Belair N.P., 2.xii.2011 (AD); *H.Goldney 3*, 474 Ackland Hill Rd, Coromandel East, 10.i.2012 (AD).

New Zealand: *R.Mason & A.E.Esker 11515*, Ngataki, roadside, 26.xi.1970 (CANB).

*Putative hybrids*

All specimens examined of both hybrids mentioned below lack the regular branching of long shoots and well-formed flanges, both characteristics typical of sect. *Pallidiflorae*.

**(i) *K. ambigua* × *K. capitata* subsp. *capitata***

This hybrid is even more variable than one of the putative parents, *K. capitata* subsp. *capitata*, but is usually recognised in the field by its white or pale pink flowers, oblong-elliptic to -oblanceolate leaves with ± tubercled margins. Herbarium specimens are easily identified by the combination of linear-elliptic ± flat leaves without obvious veins and a more or less developed constriction between the free hypanthium and the ovary, as well as usually a decreasing density of the tomentum from the ovary to the calyx lobes.

A many-stemmed shrub with spreading branches, elliptic-oblanceolate leaves and ± narrowly elliptic bracts and bracteoles, also reminiscent to those of *K. ambigua*. The few veins are usually not visible (except in *H.Deane NSW147329*). Below the distal inflorescences there are usually several short shoots terminating in inflorescences, similar to *K. ambigua.* They are ± globose and very rarely elongated as is usual in *K. ambigua*. The leaves are often broader (1.2–2.3 mm) than in that species and often with a "pinched" apex; branching occurs in growth flushes and short shoots often do not occur regularly at each node; bracts and bracteoles are membranous to chartaceous and deciduous (rarely in typical subsp. *capitata*) at flowering; a constriction between the free hypanthium and the ovary as well as a decreasing density of the indumentum from the ovary to the free hypanthium and calyx lobes are characters found in *K. capitata*. In addition the petals and filaments vary from pale to intense pink and rarely white as in *K. ambigua*. Usually a high percentage of pollen abnormalities indicate hybridity.

*Selection of specimens examined (18 examined, but many of them were without precise locality)*

New South Wales: *S.C.Burnell NSW147326*, Manly side of Middle Harbour, xi.1905 (NSW); *J.F.Camfield NSW 147325*, Spit Rd, Middle Harbour, xi.1897 (NSW); *H.Deane NSW147329*, Manly, x.1884 (NSW); *E.P.Eliott NSW147319*, s.loc., 22.x.1916 (NSW); *D.Ellison NSW147313*, near Currarong tip, 18.xi.1979 (NSW); *W.Farley NSW147330*, Dee Why Headland, 12.x.1964 (NSW); *M.Fuller 7071*, North Bridge, x.1927 (CANB); *K.Mills NSW168747*, Bollereng Ck, W Tomerong, 29.xi.1984 (NSW); *H.R.Toelken 6851*, 4 km NW Currarong, 30.x.1986 (AD, NSW) (pollen sterility 68–71%); *H.R.Toelken 6855*, 9.7 km SW Nowra airport on road to Nerriga, 30.x.1986 (AD, NSW) (pollen sterility 55–67%); *H.R.Toelken 6856*, 9.7 km SW Nowra airport on road to Nerriga, 30.x.1986 (AD, NSW) (pollen sterility 58–68%).

*Putative parents from associated area*

***K. ambigua.*** New South Wales: *H.R.Toelken 6849*, 4 km NW Currarong, 30.x.1986 (AD, NSW) (pollen sterility 5%); *H.R.Toelken 6852*, 9.7 km SW Nowra airport on road to Nerriga, 30.x.1986 (AD, NSW) (pollen sterility 4%).

***K. capitata* subsp. *capitata.*** New South Wales: *H.R. Toelken 6850*, 4 km NW Currarong, 30.x.1986 (AD, NSW) (pollen sterility 4%); *H.R.Toelken 6854*, 9.7 km SW Nowra airport on road to Nerriga, 30.x.1986 (AD, NSW) (pollen sterility 2%).

**(ii) *K. ambigua* × *K. capitata* subsp. *seminuda***

The leaves are elliptic-obovate, somewhat folded lengthwise and with slightly recurved apex resembling those of *K. capitata* subsp. *seminuda*, but unlike those their apices are pointed. The calyx lobes, which are glabrous as in the subsp. *seminuda*, are, however, similarly pointed and reminiscent to those of *K. ambigua*. Also the regular branching from all distal nodes is typical of the latter species.

*Specimens examined*

New South Wales: *M.Kempster 6*, Beecroft Penin., Long Beach South Rd, 100 m from Lighthouse Rd, 28.x.1999 (CANB).

*Putative parents from associated area*

***K. ambigua.*** New South Wales: *E.Gauba CBG 7042*, forest near Nowra, 21.x.1951 (CANB); *J.M.Powell 374 & J.McGrath*, near Tomerong, 7.xi.1975 (NSW).

***K. capitata* subsp. *seminuda.*** New South Wales: *R.L. Rudd 153 & M.McLeod*, 20 mls [32 km] NE of front gate of Australian National Botanical Gardens Annexe, Jervis Bay, 18.x.1991 (AD).

**49. *Kunzea axillaris* Toelken, *sp. nov.***

*A speciebus aliis sectionis* Pallidiflorarum *hujus calycis lobis latis brevis (ad 0.5 mm longis) inflorescentiisque tantum elongatis distalibus et bracteis foliiformibus differt.*

**Type:** New South Wales, Mt Cairncross, *T. & J.Whaite 3537*, 7.iii.1981 (holo.: AD98831018; iso.: NSW).

*Kunzea sp. A* Joy Thomps. in S.W.L.Jacobs & Pickard (eds), Pl. New South Wales 166 (1981); Peter G.Wilson in G.J. Harden (ed.), Fl. New South Wales 154 (1991); de Lange et al., Austral. Syst. Bot. 23: 311 (2010).

*Kunzea sp. Middle Brother (P.G.Wilson 505)* Peter G.Wilson in G.J.Harden (ed.), Fl. New South Wales, ed. 2, 2: 177 (2002).

Erect shrub or tree 2.5–6 (–8) m tall; young branches with raised leaf bases ± decurrent, but not forming flanges, pubescent to tomentose with short and longer spreading antrorse hairs; early bark splitting into corky longitudinal strips with scarcely peeling margins. *Leaves* alternate; *petiole* 0.4–0.7 mm long, appressed; *lamina* linear-elliptic to linear, (3–) 4–6 × 0.5–0.8 mm, acute to pointed, gradually tapering into petiole, straight to slightly recurving, flat to slightly furrowed above, strongly convex below, glabrous except for often appressed antrorse marginal hairs. *Inflorescence* a raceme-like botryum with (1–) 3–5 (–7) flowers, each with a "pedicel" (0.8–) 1–1.5 (–2.4) mm long, distal on branches, with terminal vegetative growth usually continuing while flowering; *retained perules* 2, 3 or absent below inflorescence, narrowly triangular to triangular-elliptic, 0.5–0.8 mm, 1–3-veined, puberulous to glabrous with marginal hairs; *bracts* similar to leaves, persistent; *bracteoles* leaf-like but more delicate, caducous (usually only scars seen on pedicels). *Hypanthium* 2.5–2.8 mm long when flowering (free tube 1–1.2 mm long), obconical, not ridged, glabrous. *Calyx lobes* ovate-triangular, 0.4–0.55 mm long, acute, rarely

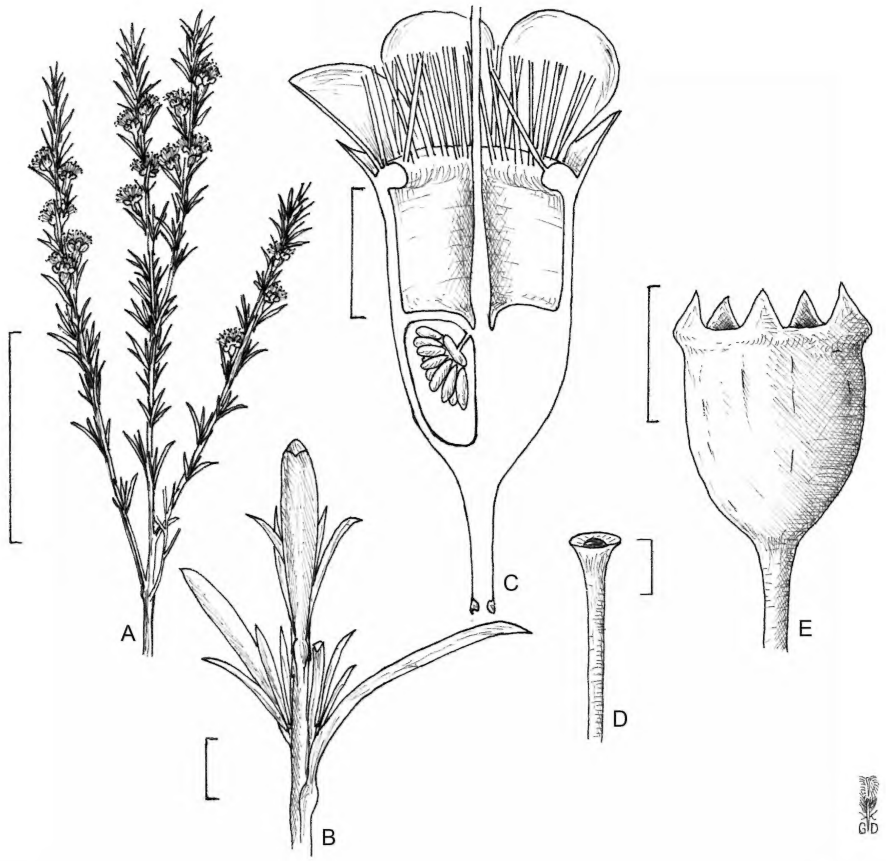


**Fig. 23.** ***K. axillaris***: **A** flowering branch; **B** short shoots in axils of cauline leaves; **C** half flower; **D** funnel-shaped stigma; **E** fruit. — Scale bars: **A** 3 cm; **B, C, E** 1 mm; **D** 0.5 mm. — **A–D** *L.Frazer NSW124240*; **E** *A.G.Floyd NE35790*.

obtuse, scarcely ridged, glabrous. *Corolla lobes* broadly obovate, obovate-orbicular, 1–1.2 mm long, white. *Stamens* 30–35 in more than one whorl; *filaments* 2.5–3 mm long; *anthers* ellipsoidal, 0.3–0.4 mm long, with small subterminal gland. *Ovary* 3-locular, with style base slightly sunk into upper surface; *placenta* a narrow-elliptic disc with short central attachment, scarcely divided into 2 lobes, each with 2 rows of ovules: *ovules* 23–25 per locule, subequal, spreading; *style* 3.5–4 mm long when fruiting, with stigma disc to funnel-shaped with distinct central depression. *Fruit* a cup-shaped capsule, 2–2.2 mm long, with erect but slightly incurved calyx lobes. *Seeds* not seen. *Flowering*: January. **Fig. 23.**

*Distribution and ecology.* Recorded from wet sclerophyll eucalyptus forest (e.g. *E. agglomerata*) on various soils but mainly around granite or conglomerate outcrops on slopes of ranges between Taree and Kempsey, New South Wales (NC).

*Conservation status*. Poorly known species recorded from a few localities in State Forests (2K).

*Diagnostic feature.* Distinguished from other species by short, broad calyx lobes, obconical hypanthium, and elongated (raceme-like) leafy inflorescences with terminal vegetative growth, which are typical of species of sect. *Niviferae*. However, *K. axillaris* is placed here, because it differs from species of the latter section by its filaments being all long and erect-spreading, as well as by its long style placing the stigma at the same level as the fully expanded stamens.

*Notes*. The flowers of this species have, like in *K. truncata*, an obconical hypanthium, which does not become cup-shaped even in the fruiting stage.

*Etymology*. The epithet "axillaris", Latin, "axillary" refers to the flowers, which appear to be single in the axils of leaves (=leaf-like bracts), but on closer examination one finds the scars of two bracteoles subtending each

flower, which makes the inflorescence a leafy botryum as is commonly found in sect. *Niviferae*.

*Specimens examined*

New South Wales: *D.Binns 170*, Mt Cairncross, 6.viii. 1987 (CANB); *D.Binns 301*, Bottlebrush Rd, Kerewong S.F., 1.iii.1988 (CANB, NSW); *J.J.Bruhl 1843 & I.R.Telford*, c. 10 km SW Wavehope, Broken Bago S.F., 12.vi.1999 (AD, CANB, NSW); *P.Burgess NSW124241*, Burrawan S.F., 24.x.1961 (NSW); *E.Cheel NSW124242*, Upper Landsdown, 6.v.1925 (NSW); *A.G.Floyd 917*, Middle Brother, 27.iv.1978 (NE, NSW); *L.Frazer NSW124240*, Comboyne, 7.i.1935 (NSW); *S.J.Griffith NE66481A*, Manning River valley, Wyuma, Killabakh Ck, 29.i.1994 (CANB); *R.Johnstone 2012 & A.E.Orme*, 80 m NW TV tower, Middle Brother, 28.iii.2007 (AD, NSW; K, NE, n.v.); *P.Richards 815*, Forest Hut Rd, Middle Brother, 15.x.1997 (NSW; BRI, MEL, n.v.); *P.G.Wilson 505*, Middle Brother Lookout, 28.i.1990 (AD, NSW; BRI, MO, n.v.).

### D.3. *Kunzea* sect. *Niviferae* Toelken & de Lange

in de Lange et al. Austral. Syst. Bot. 23: 317 (2010). — **Type species:** *K. peduncularis* F.Muell.

*Kunzea* sect. '*Eukunzea*' Benth., Fl. Austral. 3: 112 (1867), pro parte, quoad *K. peduncularis* – nom. inval.

*Leptospermum* auctt. non Forster & G.Forster: A.Rich., Essai Fl. Nouv. Zél. 338 (1832), pro parte, quoad *L. ericoides*; Cheel, J. & Proc. Roy. Soc. New South Wales 76: 230 (1943), pro parte, quoad *L. phylicoides* (A.Cunn. ex Schauer) Cheel; S.T.Blake, Proc. Roy. Soc. Queensland 69: 77 (1958), pro parte, quoad *L. phylicoides* (A.Cunn. ex Schauer) Cheel; Byrnes, Austrobaileya 1(5): 468 (1983), pro parte, quoad *L. phylicoides* (A.Cunn. ex Schauer) Cheel.

*Baeckia* auct. non L.: Schauer, Repert. Bot. Syst. 2, Suppl. 1: 921 (1843), pro parte, quoad *B. phylicoides* A.Cunn. ex Schauer.

Distal main branches with vegetative short shoots at each node shorter or as long as subtending leaves, leaf bases becoming decurrent flanges. *Inflorescence* racemiform and usually with terminal leaves; bracts ± fleshy and leaf-like; petals white; *stamens* unequal, erect-spreading or some incurved, with usually antepetalous ones longer and antesepalous ones shorter than petals, and style usually shorter than all filaments.

*Discussion*. Following Recommendation 22A.1., *Kunzea* sect. *Niviferae* was given the same name as the subgenus (McNeill et al. 2012). It includes 10 species in New Zealand (de Lange 2014) and 6 in Australia, which were only recently re-identified as kunzeas (Thompson 1983), a decision confirmed by molecular studies by O'Brien et al. (2000) and de Lange et al. (2010). They were for many years before that retained in *Leptospermum*, because of their close resemblance to some of the species of that genus.

The loose inflorescence with usually stalked flowers, the usually caducous leaf-like bracts and particularly the short often partially incurved stamens, as well as the short styles, about as long as the calyx lobes, are characteristics of this section. Some of these characters, but never the full complement, are shared with other members of subgen. *Nivifera*, and have been discussed there.

Species to be published separately (Toelken, in prep.).

## Species excluded

Thompson (1989) already transferred *K. brachyandra* F.Muell. and *K. podantha* F.Muell. to *Leptospermum brachyandrum* (F.Muell.) Druce (p. 353) and *L. oligandrum* Turcz. (p. 350), respectively. For *Metrosideros sororia* Endl. (p. 105) and *Tetraspora verrucosa* Turcz. (p. 106) see Toelken (1996).

## Acknowledgements

I am grateful to Dr John P. Jessop for his encouragement and comments on initial drafts. Many thanks also to Dr Peter de Lange for an active exchange of ideas and cooperation for many years, adding a molecular survey of the whole genus, which in turn supported the infrageneric classification adopted. His publication of the New Zealand species is a significant addition to the revision of the genus. I am also indebted to Dr Peter G. Wilson for many discussions, field work and advice. Initial guidance by Joy Thompson is also gratefully acknowledged. Thanks are also due to Mr G.R.M. Dashorst for the many illustrations, added to by Ms Lisa Waters (figs 18 & 19). I am also greatly indebted to Dr. Jürgen Kellermann for assistance with finalising the manuscript for publication.

However, no less would I like to acknowledge local assistance and information, in particular for receiving special collections from Anthony Bean, David Cameron, Allen Fairley, Allen Griinke and Jan & Robert Miller.

The loan of many specimens and assistance received while visiting herbaria are gratefully acknowledged for the following institutes: B, BM, BR, BRI, C, CANB, CBG, CGE, G, K, L, LD, MEL, NE, NSW, PERTH, W.

## References

Aston, H.I. (1984). Publication dates of early scientific journals in Victoria. *Muelleria* 5: 281–288.

Beadle, N.C.W., Evans, O.D. & Carolin, R.C. (1963). *Kunzea*. In: *Handbook of vascular plants of the Sydney district and Blue Mountains*, pp. 290–291. (Brown Gem Print: Armidale).

Bentham, G. (1867). *Kunzea*. In: *Flora Australensis, a description of plants of the Australian territory* 3: 111–118. (L.Reeve & Co: London).

Black, J.M. (1926). *Kunzea*. In: *Flora of South Australia* 3: 405. (Govt Printer: Adelaide).

Blackall, W.E. & Grieve, B.J. (1954). *Kunzea*. In: *How to know Western Australian Wildflowers* III: 97–101. (University of Western Australia Press: Nedlands).

Blackall, W.E. & Grieve, B.J. (1980). *Kunzea*. In: *How to know Western Australian Wildflowers*, ed. 2, IIIA: 97–101 (University of Western Australia Press: Nedlands).

Blake, S.T. (1958). New and critical genera and species of Myrtaceae subfamily Leptospermoideae from eastern Australia. *Proceedings of the Royal Society of Queensland* 69: 75–88.

Bostock, P.D. & Holland, A.E. (eds) (2015). *Census of the Queensland Flora 2015*. (Queensland Department of

Science, Information Technology and Innovation: Brisbane). data.qld.gov.au/dataset/census-of-the-queensland-flora-2015 [accessed: 18 July 2016].

Briggs, B.G. & Johnson, L.A.S. (1979). Evolution in the Myrtaceae – Evidence from inflorescence structure. *Proceedings of the Linnean Society of New South Wales* 102(4): 158–256.

Briggs, J.D. & Leigh, J.H. (1996). *Rare and threatened Australian plants* 1995, rev. ed. (CSIRO: Collingwood).

Buchanan, A.M. (1990). Ronald Campbell Gunn (1808–1881). In: Short, P.S. (ed.), *History of systematic botany in Australia*, pp. 179–192 (Australian Systematic Botany Society: South Yarra).

Byrnes, N.B. (1982). Notes on the genus *Kunzea* (Myrtaceae) in Queensland. *Austrobaileya* 1, 5: 468–471.

Carolin, R.C. & Tindale, M.D. (1993). *Kunzea*. In: *Flora of the Sydney Region*, ed. 4: 396–397. (Griffen Press: Adelaide).

Chapman, A.D. (1976). Name changes in *Kunzea* (Myrtaceae). *Contributions from the Herbarium Australiense* 18: 1–3.

Chapman, A.D. (1991). *Kunzea*. In: *Australian plant name index K-P*, pp. 1730–1733. (Australian Govt Printing Services: Canberra).

Cheel, E. (1943). A revision of certain species of *Leptospermeae*. *Journal & Proceedings of the Royal Society of New South Wales* 76: 230–234.

Corrick, M.G. & Fuhrer, B.A. (1996). *Wildflowers of southern Western Australia*. (The Five Mile Press: Melbourne).

De Candolle, A.P. (1828) Myrtaceae. In: *Prodromus systematis naturalis regni vegetabilis* 3: 207–296. (Treuttel & Würtz: Paris).

De Lange, P.J. & Murray, B.G. (2004). Chromosome numbers in *Kunzea* (Myrtaceae). *Australian Journal of Botany* 52: 609–617.

De Lange, P.J., Datson, P.M., Murray, B.G., Toelken, H.R. (2005). Hybridism in the *Kunzea ericoides* complex (Myrtaceae): an analysis of artificial crosses. *Australian Systematic Botany* 18: 117–131.

De Lange, P.J., Smissen, R.D., Wagstaff, S.J., Keeling, D.J., Murray, B.G., Toelken, H.R. (2010). A molecular phylogeny and infrageneric classification for *Kunzea* (Myrtaceae) inferred from rDNA ITS and ETS sequences. *Australian Systematic Botany* 23: 309–319.

De Lange, P.J. (2014). A revision of the New Zealand *Kunzea ericoides* (Myrtaceae) complex. *PhytoKeys* 40: 1–185.

Elliot, W.R. & Jones, D.L. (1993) *Encyclopaedia of Australian plants* 6: 15–26. (T.C.Lothian: Port Melbourne).

Erickson, R., George, A.S., Marchant, N.G. & Moorcombe, M.K. (1973). *Flowers and Plants of Western Australia*. (A.H. & A.W. Reed: Sydney).

Ewart, A.J. (1931). *Kunzea*. In: *Flora of Victoria*, pp. 863–865 (Victorian Govt Printer: Melbourne).

Gardner, C.A. (1964). Contibutiones florae Australiae occidentatis XIII. *Journal of the Royal Society of Western Australia* 47: 61.

Grandison, R. (1990). The 1851 botanical excursion of Ferdinand Mueller to the Flinders Ranges, South Australia. In: Short, P.S. (ed.), *History of systematic botany in Australasia* 109–113. (Australian Systematic Botany Society: South Yarra).

Harris, W., Porter, N.G., Dawson, M.I. (1992). Observation on biosystematic relationships of *Kunzea sinclairii* and on the intergeneric hybrid *Kunzea sinclairii* × *Leptospermum scoparium*. *New Zealand Journal of Botany* 30: 213–230.

Heynhold, G. (1840). *Nomenclator botanicus hortensis*, Vol. 1. (Arnoldische Buchhandlung: Dresden, Leipzig).

Heynhold, G. (1841). *Nomenclator botanicus hortensis*, Vol. 2. (Arnoldische Buchhandlung: Dresden, Leipzig).

Home, R.W., Lucas, A.M., Maroska, S., Sinkora D.A. & Voigts, J.H. (1998). *Regardfully Yours*, Vol. 1. (Peter Lang: Bern, Berlin etc.).

Jackson, B.D. (1965). *A glossary of botanic terms with their derivation and accent*, ed. 4. (Hafner Publishing Co: New York).

Jeanes, J.A. (1996). *Kunzea*. In: Walsh, N.G. & Entwisle, T.J. (eds), *Flora of Victoria* 3: 1020. (Inkata Press: Melbourne).

Johnson, L.A.S. & Briggs, B.G. (1983). Myrtaceae. In: Morley, B.D. & Toelken, H.R. (eds), *Flowering plants in Australia* 177–185 (Rigby: Adelaide).

Johnson, L.A.S. & Briggs, B.G. (1984). Myrtales and Myrtaceae – A phylogenetic analysis. *Annuals of the Missouri Botanic Gardens* 71: 700–756.

Klotzsch, J.F. (1836). *Petanogaster*, eine neue Pflanzengattung der De Candolleschen Leptospermeen mit freien Staubgefäßen. *Allgemeine Gartenzeitung, Berlin* 4: 113–116.

Lindley, J. (1839). *Appendix to the first twenty three volumes of Edwards's Botanical Register* […] *together with a Sketch of the vegetation of the Swan River Colony*. (Ridgeway: London).

Mabberley, D.J. (1980). Generic names published in Salisbury's reviews of Robert Brown's work. *Taxon* 29(5/6): 597–606.

McGillivray, D.C. (1973). Michel Gandoger's names of Australian plants. *Contributions from the New South Wales National Herbarium* 4(6): 345.

McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersema, J.H., & Turland, N.J. (eds) (2012). International Code of Nomenclature for algae, fungi, and plants (Melbourne Code): Adopted by the Eighteenth International Botanical Congress Melbourne, Australia. *Regnum Vegetabile* 154. (Koeltz Scientific Books: Königstein, Germany).

Miquel, F.A.W. (1856). Stirpes Novo-Hollandas a Ferd Müllero collectas determinavit F.A.G. Miquel. *Nederlandsch Kruidkundig Archief* 4: 97–150.

Molyneux, W.M. & Forrester, S.G. (2016). A new species *Grevillea burrowa* (Proteaceae) from the Burrowa-Pine Mountain National Park, north-eastern Victoria. *Muelleria* 34: 47–54.

Morcombe, M. (1970). *Australia's Wildflowers*. (Landsdown Press: Melbourne).

Morley, B. & Toelken, H.R. (eds) (1983). *Flowering Plants in Australia*. (Rigby: Adelaide).

Mueller, F. (1855) *Definitions of rare or hitherto underdescribed Australian plants*. (Goodhugh & Trembath: Melbourne). [preprint of *Trans. & Proc. Victorian Inst. Advancem. Sci.* 1, cf. Seberg 1986].

Mueller, F. (1863). *Callistemon haenesii*. *Fragmenta Phytographiae Australiae* 3 [XXIII]: 153. (Govt Printer: Melbourne).

Mueller, F. (1867). *Kunzea callida*. *Fragmenta Phytographiae Australiae* 6 [XLII]: 23. (Govt Printer: Melbourne).

O'Brien, M.M., Quinn, C.J. and Wilson, P.G. (2000). Molecular systematics of the *Leptospermum* suballiance (Myrtaceae). *Australian Journal of Botany* 48: 621–628.

National Herbarium of New South Wales (2016). *PlantNET: The NSW Plant Information Network System*. (Royal Botanic Gardens and Domain Trust: Sydney). plantnet.rbgsyd.nsw.gov.au [accessed: 18 July 2016].

Nicolson, D.H. (1991). A history of botanical nomenclature. *Annals of the Missouri Botanical Garden* 78: 33–56.

Northern Territory Herbarium (2015–). *FloraNT: Northern Territory Flora Online*. (Department of Land Resource Management: Darwin). eflora.nt.gov.au [accessed 18 July 2016].

Petterson, J. (2006). In preparation for a new flora of New Zealand, Vol. 1 – four puzzles in New Zealand Botany that need attention. *New Zealand Botanical Society Newsletter* 84: 14–15.

Reichenbach, H.G.L. (1828). *Kunzea*. In: *Conspectus regni vegetabilis per gradus naturales evoluti*, p. 175 (C. Cnobloch: Leipzig).

Richard, A. (1832). *Voyage de Decouvertes de L'Astrolabe. Botanique. Essai d'une Flore de La Nouvelle-Zelande*. (J. Tastu: Paris).

[Salisbury, R.A.] (1814). Art. XI. *Hortus Kewensis* [...] Art. XII. An epitome of the second edition of *Hortus Kewensis* [...]. *Monthly Review* 75: 65–83.

Schauer, J.C. (1843). Myrtaceae. *Walper's Repertorium Botanices Systematicae* 2, Suppl. 1: 921.

Schauer, J.C. (1844). *Kunzea*. In: Lehmann, J.G.C. (ed.), *Plantae Preissiannae*, vol. 1. (Meissneri: Hamburg).

Seberg, O. (1986). New information on Ferdinand J.H. Mueller's early taxonomic papers (1854–1856). *Taxon* 35: 262–271.

Smith, J.E. (1797). Botanical characters of some plants of the natural order of Myrtaceae. *Transactions of the Linnean Society of London* 3: 255–288.

Smith, J.E. (1813) *Metrosideros*. In: Rees, A. (ed.), *The Cyclopaedia; or, universal dictionary of arts, sciences, and literatures*, Vol. 23(2). (Longman et al.: London).

Sprengel, K.P.J. (1818). *Anleitung zur Kenntnis der Gewächse*, ed. 2, 2: 869. (K.A.Kümmel: Halle).

Sprengel, K.P.J. (1825). *Caroli Linnaei* […] *Systema Vegetabilum*, ed. 16, 3: 336. (sumtibus Librariae Dieterichiana: Göttingen).

Stafleu, F.A. & Cowan, R.S. (1986). *Taxonomic Literature*, Vol. 6. (Bohn, Scheltema & Holkema: Utrecht).

Sweet, R. (1830). *Sweet's Hortus Britannicus*, ed. 2. (James Ridgway: London).

Sweet, R. (1839). *Sweet's Hortus Britannicus*, ed. 3. [Don, G., ed.]. (James Ridgway: London).

Thompson, J. (1981). *Kunzea*. In: Jacobs, S.W.L. & Pickard, J. (eds), *Plants of New South Wales*. (Govt Printer: Sydney).

Thompson, J. (1983). Redefinition and nomenclatural changes within the *Leptospermum* suballiance of Myrtaceae. *Telopea* 2(4) 379–383.

Thompson, J. (1989). A revision of the genus *Leptospermum* (Myrtaceae). *Telopea* 3(3): 301–448.

Toelken, H.R. (1981a). Proposal (582) to conserve *Kunzea* Reichb. over *Kunzia* Spreng. *Taxon* 30: 350–351. [Report in *Taxon* 30: 828].

Toelken, H.R. (1981b). Proposal (664) to conserve *Kunzea* Reichenbach over *Tillospermum* Salisbury (Myrtaceae). *Taxon* 30: 828. [Confirmed in *Taxon* 33: 299].

Toelken, H.R. (1986). *Kunzea*. In: Jessop, J.P. & Toelken, H.R. (eds), *Flora of South Australia*, ed. 4, 2: 932. (Government Printer: Adelaide).

Toelken, H.R. (1996). A revision of the genus *Kunzea* (Myrtaceae). 1. The Western Australian section *Zeanuk*. *Journal of the Adelaide Botanic Gardens* 17: 29–106.

Toelken, H.R. & Craig, G.F. (2007). *Kunzea acicularis*, *K. strigosa* and *K. similis* subsp. *mediterranea* (Myrtaceae) – new taxa from near Ravensthorpe, Western Australia. *Nuytsia* 17: 385–396.

Trudgen, M.E. & Keighery, G.J. (1983). *Angasomyrtus*, a new genus of Myrtaceae (*Leptosperminae*) from Western Australia. *Nuytsia* 4(3): 435–439.

Turczaninow, P.K.N.S. (1847). Decas tertia generum adhuc non descriptorum adjectis descriptionibus nonnullarum specierum Myrtacearum xerocarpium atque umbelliferarum imperfectarum. *Bulletin de la Société Impériale* des *Naturalistes de Moscou* 20(1): 147–174.

Western Australian Herbarium (1998–). *FloraBase: the Western Australian Flora*. (Department of Parks and Wildlife: Perth). florabase.dpaw.wa.gov.au [accessed: 18 July 2016].

Willis, J.H. (1973). *Kunzea*. In: *A handbook to plants in Victoria* 2: 449–450. (Melbourne University Press: Parkville).

Wilson, K.L. (1990). William Baeuerlen – a 'circumspect and zealous' collector. In: Short, P.S. (ed.), *History of systematic botany in Australasia* 97–103. (Australian Systematic Botany Society: South Yarra).

Wilson, Paul G. (1988). The early collecting numbers of Charles A. Gardner. *Australian Systematic Botany Society. Newsletter* 54: 4.

Wilson, Peter G. (1991). *Kunzea*. In: Harden, G.J. (ed.), *Flora of New South Wales* 2: 150–154. (New Wales University Press: Kensington, NSW).

*Journal of the Adelaide Botanic Gardens* 29 (2016) 147–220


# Notes concerning the classification of species included in *Calocephalus* R.Br. s.lat. and *Gnephosis* Cass. s.lat. (Asteraceae: Gnaphalieae), with descriptions of new genera and species

*P.S. Short*

5 Chemnitz Court, Driver, Palmerston, Northern Territory 0830, Australia
*Previously*: National Herbarium of Victoria (MEL) & Northern Territory Herbarium (DNA)

## Abstract

Descriptions and keys to 40 species here included in, or which have often been considered to have affinities with the broadly-delimited genera *Calocephalus* R.Br. and *Gnephosis* Cass., are provided. Five new species are referred to *Calocephalus*, i.e. *C. badmanii* P.S.Short, *C. beardii* P.S.Short, *C. birchii* P.S.Short, *C. glabratus* P.S.Short, *C. pilbarensis* P.S.Short, and one to *Gnephosis*, i.e. *G. newbeyi* P.S.Short. The new genus *Balladonia* P.S.Short is described and the new combinations made for *B. aervoides* (F.Muell.) P.S.Short and *B. multiceps* (J.H.Willis) P.S.Short, species previously placed in *Calocephalus* and *Chthonocephalus* Steetz, respectively. The genus *Notisia* P.S.Short is described, the only species, *N. intonsa* (S.Moore) P.S.Short being transferred from *Gnephosis*. Lectotype specimens are designated for the names of 14 species and two varieties.

**Keywords:** Asteraceae, Gnaphalieae, *Balladonia*, *Blennospora*, *Calocephalus*, *Gilruthia*, *Gnephosis*, *Leucophyta*, *Notisia*, review, taxonomy, lectotypifications, pollen:ovule ratios, Australia.

## Introduction

George Bentham (1867a), in his treatment of the gnaphalioid genera of Australian Compositae (essentially his tribes "Gnaphalieae" and "Eugnaphalieae") in *Flora Australiensis*, recognised 34 genera. Excluding several orthographic variants and nomenclatural synonyms he listed 77 generic synonyms. The previous year, in a letter dated 22 July 1866 and sent to Ferdinand Mueller, Bentham had indicated his progress with his treatment of the family for the *Flora* and noted that

> So far as I have gone, I have been able (pretty well to my own satisfaction, although very likely not to that of others) very much to reduce the small genera.
>
> *Cited in Daly 1927, p. 158*

Mueller was to subsequently accept many of the genera recognised by Bentham. However, he noted, for example, that of the many names — often coined by Nicolai Turczaninow (1851) and Asa Gray (1851a, b, 1852) — reduced to synonymy under *Angianthus* Wendl., *Gnephosis* and *Myriocephalus* Benth by Bentham, "some were readily to be restituted" (Mueller 1882, pp. 82, 83). That Mueller found Bentham's work unacceptable is unsurprising given the following statements concerning generic limits in *Flora Australiensis*:

> The limits to be assigned to the group are very uncertain, as it is connected with so many others by almost insensible gradations [...] We are obliged [...] to make arbitrary demarcations, in order not to unite the whole tribe into one unmanageable genus. Those here adopted are the best that suggest themselves [...] although it must be admitted that in some instances they are not altogether satisfactory.
>
> *Bentham 1867a, p. 612, regarding the limits of* Helichrysum *in Australia*

> It is very near to *Gnephosis*, differing chiefly in the pappus. The general receptacle is also more broken up or slightly branched, the partial heads are distinct and having more florets connect the genus through *Cephalipterum* and *Gnaphalodes* with *Helipterum.*
>
> *Bentham 1867a, p. 573, regarding* Calocephalus

> It is closely allied to *Angianthus*, but the general involucre and receptacle are less developed than in that genus and the partial involucres much more so, consisting of much more numerous bracts and not flattened.
>
> *Bentham 1867a, p. 569, discussing* Gnephosis

However, non-specialist taxonomists found it convenient to simply follow Bentham's concepts and pragmatically placed new species in these genera without, surely, giving much thought to their relationships. The work of earlier taxonomists such as Gray and Turczaninow were presumably overlooked or simply ignored, with Bentham's opinions holding sway for more than a century.

As part of a study of the genus *Angianthus* (sensu Bentham) in the late 1970s, I familiarised myself with many other compound-headed species of Australian Gnaphalieae and, to a lesser extent, Australian species which at that time were still, following Bentham (1867a), included in *Helipterum* DC. and *Helichrysum*

Mill. As with Mueller, I came to the conclusion that Bentham's generic concepts left much to be desired. I have noted this to be the case for *Calocephalus* and *Gnephosis* in several publications (e.g. Short 1981a, b, c, 1986a), reinstating *Blennospora* A.Gray (Short 1987a) and subsequently *Trichanthodium* Sond. & F.Muell. ex Sond. (Short 1990a) and began (Short 1986b) to again use the name *Leucophyta brownii* Cass. for the species known for many years as *Calocephalus brownii* (Cass.) F.Muell. Anderberg (1991), in his world-wide review of the taxonomy and phylogeny of the tribe Gnaphalieae, accepted many of the smaller genera which I had reinstated from *Angianthus* s.lat. as well as recognising *Blennospora* and *Leucophyta*. He also recorded *Calocephalus* sensu Bentham as being "probably polyphyletic" and recognised that *Calocephalus angianthoides* is referable to *Gnephosis* s.str. (as defined by Short 1987b) but suggested that it would probably be paraphyletic without inclusion of monotypic *Hyalochlamys* A.Gray. Anderberg (1991) also tentatively referred those species excluded from *Gnephosis* s.str. to the genus *Leptotriche* Turcz. He made no combinations to formally accommodate them in that genus and, with the exclusion of those I have removed to *Trichanthodium* (Short 1990a) and the tentative addition here of *G. setifera* P.S.Short (Short 1990c), they constitute what I treat here as species of *Gnephosis* s.lat.

Following his morphology-based, cladistic analysis of the tribe Gnaphalieae, Anderberg (1991), placed the majority of Australian genera in the endemic subtribe Angianthinae, with most others in the subtribe Cassiniinae. The subjects of this paper, *Calocephalus* s.lat. and *Gnephosis* s.lat. were included in the Angianthinae.

Subsequent to Anderberg (1991), Bayer et al. (2002) used a molecular approach to examine phylogenetic relationships in the Australian Gnaphalieae using non-coding chloroplast DNA sequences (the *trnL* intron and *trnL/trnF* intergenic spacer), the maturase encoding plastid enzyme *matK*, and the external transcribed spacer (ETS) of nulcear DNA. For their analyses, 69 of the 87 genera then recognised were sampled, but this equated to just 77 species out of a total of 475–500 species. The results indicated that the subtribes Angianthinae and Cassiniinae as circumscribed by Anderberg (1991) are not monophyletic. Furthermore, results generally support the recognition of many of the smaller genera which have been described or reinstated in recent years in papers by, for example, myself (e.g. Short 1983, 1986c, 1987a, 1989b, 1990a) and Wilson (e.g. 1989a, b, 1992a, b, c). Bayer et al. (2002) also indicated that some genera need to be more closely investigated. It also shed little light on the relationships of the many species that have at some stage been attributed to *Calocephalus* s.lat. and *Gnephosis* s.lat., only eight (*Blennospora drummondii*, *Calocephalus knappii*, *C. multiflorus*, *Gnephosis arachnoidea*, *G. intonsa*, *Leucophyta brownii*, *Trichanthodium exilis* and *T. skirrophorum*) out of the 40 species treated here, being included in their study. In neither case were species of what I treat as *Gnephosis* s.str. and *Calocephalus* s.str. included in the analyses. On the other hand, the results support my earlier beliefs (e.g. Short 1986a) that a number of genera should be segregated from both *Calocephalus* s.lat. and *Gnephosis* s.lat. Thus, of the four species of *Calocephalus* s.lat. included in analyses, it was no surprise to see *Leucophyta* and *C. knappii* in different clades while *Blennospora drummondii* and *C. multiflora* are in yet another clade. In regard to the four species of *Gnephosis* s.lat. used in the analyses, placement of the morphologically very different *Gnephosis arachnoidea* and *G. intonsa* in different clades is similarly unsurprising. However, the placement of *Trichanthodium exilis* and *T. skirrophorum* in clades distantly removed from each other was totally unexpected. Ward et al. (2009) presented similar results in regard to Australasian Gnaphalieae members, using many of the same species as Bayer et al., but in their results both species of *Trichanthodium* are in the one clade.

A comparison of the generic concepts of Gray (1851a, b, 1852) and Turczaninow (1851), who often independently based their descriptions on duplicates collections gathered by James Drummond, with the treatment of the same taxa by Bentham (1867a) and more recent workers, principally myself and Paul Wilson, is presented in Table 1. In view of his comments that many earlier names "were readily to be restituted" one feels that Mueller (1882) would mostly approve of a reversal to the recognition of at least some of the smaller genera. However, far more work pertaining to the circumscription and status of most Australian gnaphalioid genera, particularly using molecular sequencing combined with morphological studies (e.g. as in Weber & Schmidt-Lebuhn 2015), needs to be carried out before there can be consensus on these matters. It is for this reason that, despite having been critical of past workers in simply adopting Bentham's generic concepts, I too largely adopt here what I consider to be broad, non-monophyletic concepts of *Calocephalus* and *Gnephosis.* However, I do erect two new genera, *Balladonia* and *Notisia*, and maintain several which I have previously reinstated.

I have been aware of some of the new species for 30 years or more and, although they may have phrase-names, I believe it important that they be formally named and their various features described.

I here provide descriptions of 40 species. Most are detailed, being of species which are either first-described here or of species which I have not previously covered. However, I tend to provide abridged, but updated, accounts for species which I have previously revised. Thus, under *Gnephosis* s.str., *G. angianthoides* is described in detail but *G. cassiniana* (Short 1990c) and those previously included in *Chrysocoryne* (Short 1983) have shorter accounts, as do species covered in

revisions of *Blennospora* (Short 1987a) and *Trichanthodium* (Short 1990a).

## Materials and methods

### Morphology and anatomy

During general studies of the fruit anatomy of Australian Gnaphalieae (Short et al. 1989) observations on the presence or absence of sclerenchyma in the pericarp of fruit of a few species of *Calocephalus* s.lat. and *Gnephosis* s.lat. were made. These, along with a record of the voucher specimen for the single fruit examined, are incorporated in the descriptions.

The number of vascular bundles in the pericarp, the presence and shape of of crystals in the fruit wall or testa, and cell structure in fruit and corollas and corolla venation, were mostly observed from florets preserved in 70% ethanol. Sometimes, dried material was rehydrated for c. 24 hours before being stored for a similar time in 70% ethanol. All material was mounted on a microscope slide in a few drops of Lactic Acid L.R. (88% assay). Within, at most, a couple of days, florets were suitably "cleared" and could be examined to ascertain the distribution of vascular tissue, etc. The florets examined were usually from the same voucher specimens cited for the determination of pollen:ovule ratios. I have recorded whether the cell walls of the corolla lobes and tube are straight or undulating, but given the sample-size — usually about ten but occasionally only several florets and these sometimes from the one plant — and the fact that some florets have been rehydrated, it may be that these records are not always a true reflection of their structure.

Flowering times of individual species are gleaned from label data accompanying herbarium specimens.

Pollen:ovule ratios were usually determined from spirit collections specifically gathered for this purpose, with determinations made from 5–15 individual capitula (each from a different plant and randomly collected) from one or more populations. When no spirit material was available, determinations — often from just a single floret — were made from florets removed from a dried specimen. In such cases capitula were soaked in water and a drop of detergent for 24 hours and then transferred to 70% alcohol for about the same length of time before dissection. In all cases dealt with in this paper the pollen:ovule ratio is equivalent to the number of pollen grains per floret. This is because, with the exception of heterogamous *Notisia intonsa*, plants have only bisexual florets while in *N. intonsa* the ratio of male to female florets is 1:1.

### Terminology

The terminology used in descriptions often follows that of Roque et al. (2009) but I continue to use some terms which I have previously used in other publications on the taxonomy of compound-headed Gnaphalieae (e.g. Short 1983). Thus, I refer to compound heads rather than glomerules, a term which I consider unnecessary jargon for a well-defined cluster of capitula; to the bracts which surround a capitulum as capitular bracts, not involucral bracts, as this ensures there can be no confusion of these bracts with those that may form an involucre at the base of compound heads (e.g. Short 1983); the descriptive term "receptacular bracts" rather than paleae; and to capitulum-subtending bracts — a term applied by Bentham (1867a) to a usually singular bract occurring on the adaxial side of a capitulum.

Very often, in the species examined here, there is a fairly gradual morphological change from leaf to bracts of the general involucre (leaf-like to probably more than c. 50% hyaline but with green midrib or stereome), to (when present) capitular-subtending bracts (also often c. 50% or more hyaline), to capitular bracts in which the midrib makes up a small part of the entire bract and may almost be obsolete.

Thus, capitulum-subtending bracts and capitular bracts of the species referred to in this review broadly consist of two parts, an often somewhat vegetative midrib *plus* a hyaline lamina which completely surrounds the midrib and extends above it. Depending on the species, these bracts may generally taper or dilate towards the apex but, excluding hairs or hair-like processes on the margins, the upper (or terminal) part of the lamina, i.e. that part extending above the midrib, is in many species not differentiated from the lower part of the lamina, or at most there may be a slight constriction at about the level of the midrib. However, in some species, the constriction may be prominent and, if so, the delineated terminal lamina is also often differently coloured, may be wider or narrower than the lower part of the bract, and may be reflexed. On such occasions, I have opted to follow Bentham (1867a) and other taxonomists who have described gnaphalioid taxa (e.g. Wilson 1992b), in adopting the term "claw" to refer to the lower part of the bract, while referring to the upper modified part as a "terminal lamina". At least within the Australian gnaphalioid taxa, I am aware that the terms "claw" and (simply) "lamina" are more usually applied to bracts in which the claw is purely vegetative, a hyaline or scarious lamina being only apically developed; hence my deliberate use here of "terminal lamina" (rather than simply "lamina") to distinguish it from the marginal, hyaline lamina of the claw. I also note that, as in some taxa described here, the claw may be wider than the terminal lamina, which is at variance to the normal botanical interpretation of a claw, e.g. as "a narrow, stalk-like basal portion of a petal, sepal or bract" as defined in McCusker (1999, p. 591).

The margins of hyaline bracts are commonly entire, or mostly so, throughout the bract but, in some cases, they are not, instead appearing to be ciliate and I have described them in this manner. However, I note that rather than being distinct hairs as implied by this terminology, they may be better described as having "hair-like processes" which appear to be formed by the splitting of the thin margins. This is particularly apparent, for

example, in the capitular bracts of *Gnephosis trifida* which have long hair-like processes extending from the upper margins, these particular bracts being illustrated in Short (1983, figs 9c, 10i, under the name *Chrysocoryne trifida*).

In regards to the sex of a floret I believe the terms bisexual, female, male, and neuter (although the latter does not apply to florets of species dealt with in this paper) should be used. The term "perfect" is frequently used for describing bisexual florets, e.g. Roque et al. (2009), but to the uninitiated it is a term which does not immediately convey the sex of the floret. I also have a preference for the term cypsela, not achene, for the fruit of most Asteraceae. Jeffrey (2006) considered the name cypsela to be superfluous but, as noted by various workers (e.g. Marzinek et al. 2008 and references therein), the fruit of the daisy is not homologous with the achene of other families. Indeed, Roque et al. (2009) effectively acknowledged this, but decided that it is preferable to use the more widespread term, achene.

Pappus structure is highly variable and in some species, whether one should describe a pappus element as a broad-based bristle or a highly laciniate scale or, for that matter, as bristle-like or scale-like, is a moot point. I have described them as I saw them at the time of description and acknowledge that others may perceive them differently. However, in describing features such as the number and length of pappus elements I believe I have adequately described the salient features required for identification.

Accurate determinations of floret number and size cannot be easily obtained from herbarium specimens without destroying capitula. However, for many species it was possible to obtain such determinations from spirit collections expressly collected for this purpose, as well as for the determination of pollen:ovule ratios and the study of anthers and styles. This often means that such information has been obtained from 5–15 individuals from a population and then supplemented by counts and measurements from herbarium specimens, thus expanding the likelihood that the range of variation of characters is accounted for. However, when few specimens — be they spirit or dried collections — were available I have used the abbreviation "c." in descriptions. Throughout this review Stearn (1983) has been a major source of terminology, as has been the terms for shapes as used by the Systematics Association Committee for Descriptive Terminology (1962), the latter simplified in a most useful table in Radford et al. (1974).

## Text notes

### Authors of plant names

Names of authors and their abbreviations follow Brummitt & Powell (1992). Thus, reference is made to the Russian taxonomist, Nicolai Turczaninow, the spelling also used by Stafleu & Cowan (1976–1988) but not by Marchant (1990) in his most useful paper.

### Herbarium abbreviations, type specimens and typification

Herbarium abbreviations follow Thiers (continuously updated).

If collection dates and specimen numbers are absent from specimen data, as they frequently are from early collections — including type specimens — this is not indicated by "s.dat." and "s.n.".

When citing details of type specimens I usually give the specimen citation as provided in the protologue and this is often followed by updated citation of details of the appropriate specimen(s). This is because, particularly in regard to early publications, there may be discrepancies between collection data provided in the protologue and that on the label of otherwise undoubted type specimen, the identity of which may be clarified from other information provided on the sheet and/or in the protologue, or through knowledge of the working habits of authors and the deposition of a collector's specimens. There are also times when the number of duplicates and/or their allocation to herbaria have, for various reasons, been altered susequent to publication, e.g. as to some species of *Gnephosis* described by me (Short 1983, as *Chrysocoryne*).

In this paper, and in most others I've published on the taxonomy of the tribe Gnaphalieae, I have dealt with species named by Asa Gray (1851a, b, 1852) and Nicolai Turczaninow (1851), most of which were based on specimens collected by James Drummond. I here give an account of the locality and numbering of the specimens examined by Gray in those papers.

Gray noted that he compiled his descriptions of species published in volume 9 of *Hooker's Icones Plantarum* and volumes 3 and 4 of *Hook. J. Bot. & Kew Gard. Misc.* as a result of Drummond's specimens being "placed in my hands by Sir William Hooker, for examination" (Gray 1851a, p. 97). The preceeding comment was made in the first part of the paper "Characters of some gnaphaliod Compositae of the Division Angiantheæ" in *Hook. J. Bot. & Kew Gard. Misc.* in April 1851, at a time when Gray was in Europe. Indeed, he and his wife had departed American shores on 11 June 1850 and did not return from Europe until 4 September 1851. In some previous publications (e.g. Short 1985, 1987a) I have referred to the specimens as having been forwarded to Gray by Hooker, implying that Gray examined them at Harvard University, Cambridge. However, there is no indication in "Letters of Asa Gray" (Gray 1894, compiled by his wife) that he had worked on the Drummond specimens before departing for Europe in 1850. Indeed, I have little doubt that he at least commenced compiling descriptions while in Europe, a scenario consistent with Mrs Gray recording that her husband "was able to get to Kew the last of December [1850], and spent the winter in hard work in Sir William Hooker's herbarium, which was then in his house at West Park." (Gray 1894, p. 377). The fact that some species described by Gray were also

illustrated by Walter Hood Fitch, who was employed by William Hooker and the regular artist for *Hooker's Icones Plantarum*, is also consistent with this scenario. However, the fact that the last instalment of "Characters ..." was not published until September 1852 suggests that some of the work may have been carried out on Gray's return to Cambridge.

The aforementioned information suggests that syntype specimens should be at K and GH and this is the case, with the principal specimens undoubtedly at K and normally chosen by me as the lectotype specimen of each of the Gray's names. They are stamped as "Herbarium Hookerianum 1867", sheets are named in Gray's hand, and there are illustrations on some sheets — not just published ones, but also unpublished sketches which were marked as "Ic. Pl. tab. ined." in the "Characters ..." paper but were never actually published. That the K specimens should be considered the principal types is refelected in the fact that syntypes of all species named by Gray are not in GH, and those present are comparatively poor, even fragmentary, compared to the specimens in K. For example, the only material in GH of the species of *Gnaphalodes* A.Gray consist of fragmentary material held in an envelope, on which Gray wrote "Gnaphalodes n. gen. Debris examined of the 2 species. Swan R. Drummond." (Short 1985).

During the 1850/51 trip Gray visited other botanists in Europe, not just Hooker. Visits included a two-month-long spell with George Bentham at his residence in Herefordshire — albeit predominantly working on plants of the United States Exploring Expedition — while much of April was spent in Paris, "where he worked busily through the mornings at the Jardin des Plantes" (Gray 1894, p. 381). After returning from Paris he again spent time at Kew, perhaps some time in the herbarium of the British Museum, i.e. in the herbarium now known as BM, as well as meeting again with Bentham before departing for home. The Kew herbarium today houses Bentham's set of Drummond's collections — these stamped as "Herbarium Benthamianum 1854" — but, almost invariably, they lack any indication that they were seen by Gray when compiling the "Characters ..." paper. (I haven't thoroughly checked all relevant specimens, but that of *Myriocephalus nudus* A.Gray has the pencilled name on the sheet (K 000899267) in what I believe is in Gray's hand.) I have not made an extensive search for specimens at BM, but of the few which I have seen, e.g. of *Gnaphalodes condensatum* A.Gray and *Blennospora drummondii* A.Gray (Short 1987a), there was nothing on the sheets to indicate that they had been examined by Gray. However, there are some relevant Drummond collections in P which are annotated by Gray, as for example, syntype specimens of the aforementioned *G. condensatum* (P 00715970) and *B. drummondii* (P 00715973), described respectively in August 1852 and June 1851. Gray never dated his annotations but if he saw the specimens in April 1851 then, those annotated can, at least potentially, be considered to be syntypes; however, whether they were actually used to write descriptions is debatable, particularly in regard to species described in June but only seen in April. In any case, there can be no argument against the K specimens being considered as the principal types, either being considered as the holotype or chosen as the lectotype specimen of a name. However, this can be problematic due to Gray never citing Drummond's specimen numbers for any of the species he described in the "Characters ..." paper (Table 1), this despite many of them being numbered. This is in marked contrast to Turczaninow who gave the specimen number and, usually, the series to which it belonged (Table 1). Various taxonomists have commented on Drummond's collections, see for example Barker (2005) and George (2009) and references therein, but in regard to the lack of numbers I allow Bentham to explain:

> Of the important and extensive West Australian collections of Mr. James Drummond I have had for examination complete sets of excellent specimens in the Kew herbaria, and in the majority of instances I have seen them in different sets so as to check the one with the other. I have thus been enabled to identify nearly the whole of the species published by Turczaninow in the 'Bulletin de la Société Impériale des Naturalistes de Moscou.' As these collections are very generally distributed, I have quoted the numbers attached to the specimens where I could do it with any certainty. Unfortunately there is much confusion in some of these numbers, Mr. Drummond having recommenced a fresh series with each of the five collections he sent over, besides one or two supplementary sets. The first collection, of which many were published by Lindley and others, were not originally numbered, but numbers were afterwards added in a few additional sets sent home. *In the Hookerian herbarium, owing to the belief at the time that these numbers were not certain enough for quotation, they were often not preserved; in most instances where they are kept there is no indication of which series they belong to, and in other herbaria I have often found them referred to a wrong series* [my emphasis]. These numbers cannot therefore be relied on absolutely for identification without checking them by descriptions.
>
> *Bentham 1863, p. 10 of preface*

Thus, on searching K for syntypes specimens examined by Gray, one may be confronted with only unnumbered specimens (e.g. as in *Nematopus effusus*), only numbered specimens, or both numbered and unumbered specimens, for any given name coined by him. Apparent duplicates of such specimens are also to be seen in an array of other herbaria in addition to BM, GH, K and P. These include E, KW (including Turczaninow's holotypes, which are also isotypes or likely to be isotypes of Gray's names), MEL (from Drummond's original herbarium, plus other purchased duplicates), NSW, PERTH, and TCD. I also note that duplicates of gnaphalioid species, other than those acquired from Hooker by Gray, are also in GH, these having come through the purchase of F.W. Klatt's herbarium of Compositae in 1898. In cases where there are both unnumbered and numbered Drummond specimens of the same taxon and all appearing to have been part of a single gathering, it seems highly likely that, where

all apparent duplicates have the same number, they and the unnumbered ones are all part of the same gathering. However, in such cases, having selected a numbered specimen as a lectotype, both here and in various other papers, I have referred to the likely, but unumbered, duplicates as "possible" or "probable" isolectotypes; the reverse is the case if the lectotype is an unnumbered specimen.

I examined a number of type specimens from European and North American herbaria prior to their specimens receiving herbarium sheet numbers. With the advent of the JSTOR Plant Science web site (plants.jstor.org) and individual herbarium web sites for E, G, GH, K, NY, P and W, I have been able to add sheet numbers for some of these, this being done up to 12 April 2016. For all other cited specimens it should be assumed that I have seen them unless otherwise indicated by "n.v.". It should be noted that, in not having institutional access, I have not corrected occasional errors or misinterpretations pertaining to specimen on these websites.

**Publication dates**

As previously noted (Short 1983, 1995a), in 1851 and 1852 the botanists Asa Gray and Nicolai Turczaninow independently described a suite of new genera and species of Australian Gnaphalieae frequently based on duplicates, or possible duplicates, of specimens collected by James Drummond in Western Australia.

Turczaninow's descriptions appeared, under the heading "Synanthereae. Quaedam hucusque indescriptae", in two parts in *Bull. Soc. Imp. Naturalistes Moscou*. The volume and dates, as summarised in Marchant (1990) and Short (1995a) are: Vol. 24 (part 1, number 1), pp. 166–214 (27 March 1851) and Vol. 24 (part 2, number 3), pp. 59–95 (Aug.–Oct. 1851). For discussion of the problems with the determination of publication dates for this journal see Marchant (1990).

The publication dates of Gray's article entitled "Characters of some Gnaphalioid Compositae of the division Angiantheae" appeared in five parts of *Hooker's J. Bot. & Kew Gard. Misc.*, the volume and dates of publication gleaned from Stafleu & Cowan (1976–1988) being Vol. 3, pp. 97–102 (April 1851), Vol. 3, pp. 147–153 (May 1851), Vol. 3, pp. 172–178 (June 1851), Vol. 4, pp. 225–232 (Aug. 1852) and Vol. 4, pp. 266–276 (Sep. 1852).

Gray also described several of his species, *Dimorpholepis australis*, *Diotosperma drummondii* and *Scyphocoronis viscosa*, in plates 854–856 of volume 9 of *Hooker's Icon. Pl.* as well as in *Hooker's J. Bot. & Kew Gard. Misc.* Stafleu & Cowan (1976–1988) recorded that plates 801–888 were published April–December 1851; Turzaninow published his respective names for these species in August–October 1851. As previously noted (Short 1995a), having examined correspondence between Asa Gray and William Hooker and checked records of publication in *Gardeners Chronicle*, I concluded that it is possible plates 854–856 were not published until late in 1851; Paul Wilson (1992b, citing Charles Jeffrey) independently stated that plate 856 "appeared between September and November 1851 or possibly later"; this information suggests that Turczaninow's names have priority over those published by Gray in plates 854–856 of *Hooker's Icon. Pl.* and is accepted here.

As Bentham (1867a), in volume three of *Flora Australiensis*, dealt with the 24 names coined by each of the aforementioned authors, he too would have assessed the priority of the respective names. He was, perhaps, privy to better documentation of the publication dates of the aforementioned journals and, to assess the likelihood that the dates — or at least the order — of publication as accepted here are correct, I have compared his choice of epithets with those used here (Table 1). For all but six species, the epithet chosen by Bentham is in accord with that accepted here. Of the six exceptions, four were published in *Hooker's J. Bot. & Kew Gard. Misc.*:

*Asteridea multiceps* Gray (Sep. 1852): clearly a later name than *Trichostegia asteroides* Turcz. (Aug.–Oct. 1851) and a simple mistake by Bentham as he used Turczaninow's names for two other pairs of species (*Conanthodium drummondii* A.Gray/*Argyroglottis turbinata* Turcz. and *Acroclinium phyllocephalum* A.Gray/*Helipterum fuscescens* Turcz.) with the same dates of publication.

*Antheidosorus gracilis* A.Gray (June 1851): treated by Bentham as being earlier than *Gilberta tenuifolia* Turcz. (March 1851) and perhaps reflecting the fact that the generic name *Antheidosorus* was published in April 1851, albeit still a few weeks later than the date accepted here for the publication of Turczaninow's name.

*Cephalosorus phyllocephalus* A.Gray (May 1851): treated as being earlier than *Piptostemma carpesioides* Turcz. (March 1851).

*Chrysocoryne myosuroides* A.Gray (May 1851): treated as being earlier than *Chrysocoryne uniflora* Turcz. (March 1851).

In regard to the acceptance by Bentham of the names *Cephalosorus phyllocephalus* over *Piptostemma carpesioides* and *Chrysocoryne myosuroides* over *Chrysocoryne uniflora* there is another pair of species with these same dates of publication, *Nematopus effusus* A.Gray (May 1851) and *Gnephosis arachnoidea* Turcz. (March 1851). However, in this case, Bentham inconsistently gave Turczaninow's name priority.

The remaining two exceptions (of the six) were first published in *Hooker's Icon. Pl.* and Bentham was inconsistent in his choice, giving priority to Gray's *Dimorpholepis australis* (pl. 856) and *Scyphocoronis viscosa* (pl. 854) but not to *Diotosperma drummondii* (pl. 855) — the middle plate — for which he adopted the name *Ceratogyne obionoides* Turcz.

The general agreement in Bentham's choice of epithet, and the inconsistencies in choice where they differ, support the order of publication used here.

Turczaninow's article, "Synanthereae. Quaedam hucusque indescriptae", was published as a reprint and

pagination differs to that in *Bull. Soc. Imp. Naturalistes Moscou* (Stafleu & Cowan 1976–1988). I only have copies of a few relevant pages and make no further reference to the reprint in this paper.

**Order of species' descriptions**

Individual accounts of species included in both *Calocephalus* s.lat. and *Gnephosis* s.lat. are ordered alphabetically by name. It helps in finding an account but is also a reflection of the fact that both groups are ill-defined and surely not monophyletic. In contrast, species I place in *Blennospora*, *Calocephalus* s.str. and *Gnephosis* s.str. are ordered by possible relationship, these mostly previously discussed in earlier papers, i.e. for *Blennospora* in Short (1987a), for *Gnephosis* s.str. mostly in Short (1983, under the name *Chrysocoryne*), and for *Trichanthodium* in Short (1990a).

**Distribution**

I give a brief summation of the distribution of each taxon, but do not provide maps. For distribution I suggest accessing Australia's Virtual Herbarium (chah.gov.au/avh/). Providing specimens are correctly identified maps displayed there should be more up-to-date than anything I can provide as, although my field work substantially added to the number of specimens of some species used to complete this review, I have seen few additional specimens to those I collected or received on loan more than 20 years ago.

**Pollen:ovule ratios**

Cruden (1977) showed that pollen:ovule ratios are a conservative indicator of breeding systems in flowering plants. That this is the case, has been documented for many species of Australian Asteraceae, e.g. Lawrence (1985), and Short (1981a, 1983, 1985, 1986c, 1987a, b, 1989a, b, 1990a, b, c, 1995a, b, 2000, 2014). While Cruden (1977) and Lawrence (1985) assessed whether the species they examined were self-compatible or self-incompatible, I have usually not had such information. However, the differences in P:O ratios are commonly correlated with an array of morphological differences which are well known to be indicative of differences in breeding systems. For example, in *Millotia*, a genus of 16 species (Short 1995a, b), the ten species deemed to be outcrossers have 5 conspicuous corolla lobes more than 0.35 mm long; style apices which are conspicuously dilated and/or have prominent sweeping hairs; 5 stamens conspicuously exserted at anthesis; anthers with microsporangia c. 0.4–1.1 mm long; and c. 1,100–3,300 pollen grains per floret. The six species deemed to be predominantly selfing inbreeders usually have 3 corolla lobes (or, if 5, then comparatively inconspicuous and less than 0.35 mm long); style apices which are comparatively inconspicuous; stamens which are not conspicuously exserted at anthesis; anthers with microsporangia c. 0.2–0.6 mm long; and c. 60–600 pollen grains per floret. Species of *Millotia*, as are most other species of Australian gnaphalioid taxa for which I have published P:O ratios have only bisexual florets, which mean that P:O ratios are equivalent to the number of pollen grains per floret. I am aware that more than 30 native genera of Australian Asteraceae — all containing predominantly or only herbaceous, annual species — contain one or more species with low P:O values and associated morphological features which are indicative of a high degree of self-pollination. Just a few species treated here have pollen:ovule ratios of several hundred, including *Notisia intonsa* and the newly-described *Gnephosis newbeyi.*

**Specimens examined**

Three to five representative specimens are usually cited for each State in which a species occurs. For species, particularly new species, for which there are fewer than about ten collections, I usually cite all specimens examined.

**Key to genera (p. 161)**

Bayer et al. (2006) presented a key to all genera of the Gnaphalieae. As an aid to their identification, species which are, or have been commonly included in *Calocephalus* and *Gnephosis* by Bentham (1867a) and subsequent workers, are keyed out here, the exceptions being *Calocephalus chrysanthes* Schltdl. (now in *Pycnosorus* Benth.), and both *C. globosus* M.B.Scott & Hutch. and *C. gnaphalioides* Hook. in T.Mitch. which were transferred to *Rhodanthe* Lindley by Wilson (1992b). For publication details of these three species see "Excluded Names" (p. 213).

Descriptions, sometimes abbreviated if previously treated in a revision, are usually provided in the taxonomy section. However, three — *Lemooria burkittii* (Benth.) P.S.Short [syn: *Gnephosis burkittii* Benth.; *Angianthus burkittii* (Benth.) J.M.Black]; *Myriocephalus pygmaeus* (A.Gray) P.S.Short [syn. *Gnephosis pygmaea* (A.Gray) Benth.]; and *Stuartina muelleri* Sond. [syn. *Gnephosis rotundifolia* Diels] — are only treated in the following key, but the additional notes in parentheses should enable identification. If not, then appropriate publications dealing with these taxa are included under "Excluded Names" (p. 213).

**Table 1.** New names applied by Gray and Turczaninow to species whose names were based on specimens (mostly duplicates) collected by James Drummond, compared with names used by Bentham (1863) and those currently accepted. Arranged alphabetically by current names.

| Current name | A. Gray | N. Turczaninow | G. Bentham |
|---|---|---|---|
| *Actinobole condensatum* (A.Gray) P.S.Short, Muelleria 4: 413 (1981). | ***Gnaphalodes*** *condensatum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 228 (Aug. 1852). Type: "Swan River, *Drummond*." Single specimen, Herb. | n/a | *Gnaphalodes condensatum* A.Gray; Benth., Fl. Austral. 3: 578 (1867). |
| *Actinobole uliginosum* (A.Gray) H.Eichler, Taxon 12: 295 (1963). | ***Gnaphalodes*** *uliginosum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 228 (Aug. 1852). Type: "Swan River, *Drummond*." | n/a | *Gnaphalodes uliginosum* A.Gray; Benth., Fl. Austral. 3: 578 (1867). |
| *Angianthus pygmaeus* (A.Gray) Benth.; P.S.Short, Muelleria 5: 175 (1983). | *Skirrhophorus pygmaeus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 148 (May 1851). Type: "South-western Australia, *Drummond*." | *Skirrhophorus mucronulatus* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 72 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 59.*" | *Angianthus pygmaeus* (A.Gray) Benth., Fl. Austral. 3: 567 (1867). |
| *Argentipallium tephrodes* (Turcz.) Paul G.Wilson, Nuytsia 8: 460 (1992). | n/a | *Ozothamnus tephrodes* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 73 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 385.*" | *Helichrysum obtusifolium* var. *tephrodes* (Turcz.) Benth., Fl. Austral. 3: 619. |
| M***Argyroglottis*** *turbinata* Turcz.; N.T.Burb., Austral. J. Bot. 6: 233 (1958). | ****Conanthodium*** *drummondii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 273 (Sept. 1852). Type: "South-west Australia, *Drummond*, 1850." | ***Argyroglottis*** *turbinata* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 84, t. 1 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. coll. V. n. 63.*" | *Helichrysum argyroglottis* Benth., Fl. Austral. 3: 626 (1867), nom. illeg. |
| *Asteridea asteroides* (Turcz.) Kroner, Mitt. Bot. Staatssamml. München 16: 135 (1980). | *Asteridea multiceps* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 274 (Sept. 1852). Type: "South-west Australia, *Drummond*." | ****Trichostegia*** *asteroides* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 81 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. coll. V. n. 66.*" | *Athrixia multiceps* (A.Gray) Benth., Fl. Austral. 3: 599 (1867). |
| *Asteridea gracilis* A.Gray; Kroner, Mitt. Bot. Staatssamml. München 16: 136 (1980). | *Asteridea gracilis* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 274 (Sept. 1852). Type: "Swan River, *Drummond*." | n/a | *Athrixia gracilis* (A.Gray) Benth., Fl. Austral. 3: 600 (1867). |
| *Asteridea nivea* (Steetz) Kroner; Mitt. Bot. Staatssamml. München 16: 138 (1980). | *Asteridea stricta* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 275 (Sept. 1852). Type: "Swan River, *Drummond*." | n/a | *Athrixia stricta* (A.Gray) Benth., Fl. Austral. 3: 600 (1867). |
| ***Blennospora*** *drummondii* A.Gray; P.S.Short, Muelleria 6: 355 (1987). | ***Blennospora*** *drummondii* A.Gray, Hook. J. Bot. Kew Gard. Misc. 3: 173 (June 1851). "Swan River, *Drummond*." | n/a | *Calocephalus drummondii* (A.Gray) Benth., Fl. Austral. 3: 574 (1867). |
| †*Calocephalus multiflorus* (Turcz.) Benth. | ****Achrysum*** *glomeratum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 229 (Aug. 1852). Type: "Swan River, *Drummond*." | *Pachysurus multiflorus* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 192 (27 March 1851). Type: "Nova Hollandia. *Drum. coll. III. n. 117.*" | *Calocephalus multiflorus* (Turcz.) Benth., Fl. Austral. 3: 576 (1867). |
| M***Cephalipterum*** *drummondii* A.Gray; Paul G.Wilson, Nuytsia 8: 418 (1992). | ****Cephalipterum*** *drummondii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 271 (Sept. 1852). Type: "Variat α, appendicibus radiantibus involucri lacteis; et β, flavidis in sicco subæruginosis. Swan River, *Drummond*." | n/a | *Cephalipterum drummondii* A.Gray; Benth., Fl. Austral. 3: 577 (1867). |
| M***Cephalosorus*** *carpesioides* (Turcz.) P.S.Short, Muelleria 5: 183 (1983). | ****Cephalosorus*** *phyllocephalus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 152 (May 1851). Type: "Swan River, *Drummond*, 1846, 1848." "**Ic. Pl. tab. ined.**" | ****Piptostemma*** *carpesioides* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 192 (27 March 1851). Type: Nova Hollandia. *Drum. coll. IV. n. 200.*" | *Angianthus phyllocephalus* (A.Gray) Benth., Fl. Austral. 3: 565 (1867). |

| Current Name | A. Gray | N. Turczaninow | G. Bentham |
|---|---|---|---|
| [M]***Ceratogyne*** *obionoides* Turcz. | *****Diotosperma drummondii*** A.Gray, Hooker's Icon. Pl. 9: t. 855 (late 1851; see Short 1995); Hooker's J. Bot. & Kew Gard. Misc. 4: 276 (Sept. 1852). Type: "South-western Australia, *Drummond*." (Given as such in both publications.) | *****Ceratogyne obionoides*** Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 69, t. 1 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. coll. V. n. 56.*" | *Ceratogyne obionoides* Turcz.; Benth., Fl. Austral. 3: 555 (1867). |
| *Chrysocephalum semipapposum* subsp. *occidentale* (Benth.) Paul G.Wilson, Nuytsia 27: 71 (2016). | n/a | *Chrysocephalum canescens* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 196 (27 March 1851). Type: "Nova Hollandia occidentalis. *Gilb. coll. n. 285.*" | *Helichrysum apiculatum* var. *occidentalis* Benth., Fl. Austral. 3: 625 (1867). |
| *Chrysocephalum semipapposum* subsp. *occidentale* (Benth.) Paul G.Wilson, Nuytsia 27: 71 (2016). | n/a | *Chrysocephalum glabratum* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 197 (27 March 1851). Type: "Nova Hollandia. *Drum. III. n. 115.*" | *Helichrysum apiculatum* var. *occidentalis* Benth., Fl. Austral. 3: 625 (1867). |
| *Chthonocephalus pseudevax* Steetz; P.S.Short, Muelleria 7: 232 (1990). | *Chthonocephalus drummondii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 178 (June 1851). Type: "Swan River, *Drummond*." | n/a | *Chthonocephalus pseudevax* Steetz; Benth., Fl. Austral. 3: 582 (1867) |
| [D]***Dithyrostegia*** *amplexicaulis* A.Gray | *****Dithyrostegia*** *amplexicaulis* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 100 (April 1851). Type: "South-western Australia, *Drummond*, 1850." "**Ic. Pl. tab. ined.**" | *****Gamozygis*** *flexuosa* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 76, t. 1 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 57.*" | *Angianthus amplexicaulis* (A.Gray) Benth., Fl. Austral. 3: 568 (1867). |
| [M]***Epitriche*** *demissus* (A.Gray) P.S.Short, Muelleria 5: 181 (1983). | *Skirrhophorus demissus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 149 (May 1851). Type: "South-western Australia, *Drummond*." "**Ic. Pl. tab. ined.**" | *****Epitriche*** *cuspidata* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 75 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 58.*" | *Angianthus demissus* (A.Gray) Benth., Fl. Austral. 3: 567 (1863). |
| *Erymophyllum ramosum* (A.Gray) Paul G.Wilson, Nuytsia 7(1): 108 (1989). | *Pteropogon ramosus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 270 (Sept. 1852). (In sect. ***Helipteroides*** A.Gray). Type: "Swan River, *Drummond*." | n/a | *Helipterum tenellum* auct. non Turcz.; Benth., Fl.Austral. 3: 646 (1867). |
| *Erymophyllum tenellum* (Turcz.) Paul G.Wilson, Nuytsia 7(1): 114 (1989). | *Pteropogon gracilis* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 269 (Sept. 1852). (In sect. ***Helipteroides*** A.Gray). Type: "Swan River, *Drummond*." | *Helipterum tenellum* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 198 (27 March 1851). Type: "Nova Hollandia occidentalis. *Gilb. n. 272.*" | *Helipterum gracile* (A.Gray) Benth., Fl. Austral. 3: 646 (1867). |
| [M]***Gilberta*** *tenuifolia* Turcz.; Paul. G.Wilson, Nuytsia 8: 419 (1992). | *****Antheidosorus*** *gracilis* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 174 (June 1851). Type: "Swan River. *Drummond*." "**Ic. Pl. tab. ined.**" | *****Gilberta*** *tenuifolia* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 193 (27 March 1851). Type: "*Gilbert coll. n. 277.*" | *Myriocephalus gracilis* (A.Gray) Benth., Fl. Austral. 3: 559 (1867). |
| *Gnaphalium indutum* Hook.f. subsp. *indutum*; Paul G.Wilson, Nuytsia 18: 292 (2008). | n/a | *Gnaphalium sericeum* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 83 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 392.*" | *Gnaphalium indutum* Hook.f.; Benth., Fl. Austral. 3: 655 (1867). |
| †*Gnephosis arachnoidea* Turcz. | *****Nematopus*** *effusus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 150 (May 1851). Type: "Swan River, *Drummond*." | *Gnephosis arachnoidea* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 189 (27 March 1851). Type: "Nova Hollandia. *Drum. coll. III. n. 120.*" | *Gnephosis arachnoidea* Turcz.; Benth., Fl. Austral. 3: 571 (1867). |

| Current name | A. Gray | N. Turczaninow | G. Bentham |
|---|---|---|---|
| †*Gnephosis brevifolia* (A.Gray) Benth. | *Crossolepis brevifolia* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 175 (June 1851). Type: "S.W. Australia, *Drummond*, 1850." | *Myriocephalus cotuloides* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 73 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 61.*" | *Gnephosis brevifolia* (A.Gray) Benth., Fl. Austral. 3: 572 (1867). |
| †*Gnephosis brevifolia* (A.Gray) Benth. | *Crossolepis eriocephala* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 176 (June 1851). Type: "South-western .W. Australia, *Drummond*, 1850." | *Myriocephalus villosissimus* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 74 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 62.*" | *Gnephosis eriocephala* (A.Gray) Benth., Fl. Austral. 3: 573 (1867). |
| *Gnephosis drummondii* (A.Gray) P.S.Short, Muelleria 6: 317 (1987) | *Chrysocoryne drummondii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 152 (May 1851). Type: "Swan River, *Drummond*, 1845. | n/a | *Angianthus tenellus* (F.Muell.) Benth., Fl. Austral. 3: 564 (1867). |
| *Gnephosis uniflora* (Turcz.) P.S.Short, Muelleria 6: 318 (1987). | *Chrysocoryne myosuroides* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 152 (May 1851). Type: "Swan River, Drummond. 1845." | *Chrysocoryne uniflora* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 188 (27 March 1851). Type: "Nova Hollandia. *Drum. coll. III. n. 116.*" | *Angianthus myosuroides* (A.Gray) Benth., Fl. Austral. 3: 563 (1867). |
| [M]***Hyalochlamys*** *globifera* A.Gray; P.S.Short, Muelleria 5: 203 (1985). | ***Hyalochlamys*** *globifera* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 101 (April 1851). Type: "Swan River, *Drummond*." "**Ic. Pl. tab. ined.**" | n/a | *Angianthus globifer* (A.Gray) Benth., Fl. Austral. 3: 567 (1867). |
| *Hyalosperma demissum* (A.Gray) Paul G.Wilson, Nuytsia 7: 85 (1989). | *Pteropogon demissus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 269 (Sept. 1852). (In sect. ***Pteropogonopsis*** A.Gray). "Swan River, *Drummond*." | n/a | *Helipterum exiguum* F.Muell.; Benth., Fl. Austral. 3: 649 (1867). |
| *Hyalosperma pusillum* (Turcz.) Paul G.Wilson, Nuytsia 7: 97 (1989). | n/a | *Helipterum pusillum* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 77 (Aug.–Oct. 1851). Type: "Cum præcedente *Drum. V. n. 384.*" [The preceeding was *H. fuscescens* from Nova Hollandia.] | *Helipterum cotula* (Benth.) DC.; Benth., Fl. Austral. 3: 644 (1867). |
| *Leiocarpa semicalva* (F.Muell.) Paul G.Wilson subsp. *semicalva*; Paul G.Wilson, Nuytsia 13: 602 (2001). | n/a | *Helichrysum ambiguum*, Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 195 (27 March 1851), nom. illeg. Type: "Nova Hollandia. *Drum. III. n. 121. et IV. n. 220.*" | *Leptorhynchos ambiguus* (Turcz.) Benth., Fl. Austral. 3: 609 (1867). |
| *Millotia major* (Turcz.) P.S.Short, Muelleria 7: 246 (1990). | **Scyphocoronis viscosa* A.Gray, Hooker's Icon. Pl. 9: t. 854 (late 1851), Hooker's J. Bot. & Kew Gard. Misc. 4: 225 (Aug. 1852). | *Toxanthes major* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 64 (Aug.–Oct. 1851) ("Toxanthus"). Type: "Nova Hollandia. *Drum. coll. V. n. 53.*" | *Scyphocoronis viscosa* A.Gray; Benth., Fl. Austral. 3: 592 (1867). |
| *Millotia perpusilla* (Turcz.) P.S.Short, Muelleria 7: 246 (1990). | **Anthocerastes drummondii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc.4: 226 (Aug. 1852). Type: "Swan River, *Drummond*." | **Toxanthes perpusilla* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 177 (27 March 1851). Type: "Nova Hollandia. *Drum. coll. IV. n. 203.*" | *Toxanthes perpusillus* Turcz.; Benth., *Fl. austral* 3: (1867). |
| *Myriocephalus helichrysoides* A.Gray; P.S. Short, Austral. Syst. Bot. 13: 734 (2000). | *Myriocephalus helichrysoides* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 175 (June 1851). Type: "Swan River, *Drummond*." | n/a | *Myriocephalus helichrysoides* A.Gray; Benth., Fl. Austral. 3: 559 (1867). |
| *Myriocephalus nudus* A.Gray; P.S.Short, Austral. Syst. Bot. 13: 734 (2000). | *Myriocephalus nudus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 174 (June 1851). Type: "Swan River, *Drummond*." | n/a | *Myriocephalus nudus* A.Gray; Benth., Fl. Austral. 3: 558 (1867). |

| Current Name | A. Gray | N. Turczaninow | G. Bentham |
|---|---|---|---|
| *Myriocephalus pygmaeus* (A.Gray) P.S.Short in W.R.Elliot & D.L.Jones, Encyc. Austral. Pl. 6: 471 (1993) (as "pygmaea"). | *Crossolepis pygmaea* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 177 (June 1851). Type: "South-western Australia, *Drummond*." | ***Leptotriche** *perpusilla* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 73 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. coll. V. n. 60.*" | *Gnephosis pygmaea* (A.Gray) Benth., Fl. Austral. 3: 572 (1867). |
| *Panaetia lessonii* Cass., Ann. Sci. Nat. 17: 417 (1829). Cytological (Watanabe et al. 1999) and morphological (e.g. Short et al. 1989) differences plus molecular analyses (Konishi et al. 2000) support reinstatement of *Panaetia* Cass. | n/a | *Podolepis gilbertii* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 195 (27 March 1851). Type: "Nova Hollandia occidentalis. *Gilbert coll. n. 269 et 282.*" | *Podolepis lessonii* (Cass.) Benth., Fl. Austral. 3: 606 (1867). |
| *Podolepis aristata* subsp. *auriculata* (DC.) Jeanes, Muelleria 33: 41 (2015). | n/a | *Podolepis pallida* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 78 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. coll. V. n. 387.*" | *Podolepis pallida* Turcz.; Benth., Fl. Austral. 3: 605 (1867). |
| *Podotheca gnaphalioides* Grah., Bot. Mag. t. 3920 (1842); P.S. Short, Muelleria 7: 48 (1989). | *Podotheca pygmaea* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 227 (Aug. 1852). Type: "Swan River, *Drummond*." | n/a | *Podotheca gnaphalioides* Grah.; Benth., Fl. Austral. 3: 601 (1867). |
| *Rhodanthe* (sect. ***Achyroclinoides***) *corymbosa* (A.Gray) Paul G.Wilson, Nuytsia 8: 401 (1992). | *Pteropogon corymbosus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 268 (Sept. 1852). (In sect. ***Achyroclinoides*** A.Gray). Type: "Swan River, *Drummond*.— Darling Range, South-west Australia, *Collie*." | n/a | *Helipterum corymbosum* (A.Gray) Benth., Fl. Austral. 3:649(1867). |
| *Rhodanthe* (sect. ***Achyroclinoides***) *laevis* (A.Gray), Paul G.Wilson, Nuytsia 8: 402 (1992.) | *Pteropogon laevis* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 402 (Sept. 1852). (In sect. ***Achyroclinoides*** A.Gray). Type: "Swan River, *Drummond*, 1843." | n/a | *Helipterum laeve* (A.Gray) Benth., Fl. Austral. 3: 649(1867). |
| *Rhodanthe* (sect. ***Achyroclinoides***) *polycephala* (A.Gray) Paul G.Wilson, Nuytsia 8: 404 (1992). | *Pteropogon polycephalus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 268 (Sept. 1852). (In sect. ***Achyroclinoides*** A.Gray). Type: "Swan River, Drummond." | n/a | *Helipterum polycephalum* (A.Gray) Benth., Fl. Austral. 3: 649 (1867). |
| *Rhodanthe* (sect. *Citrinae*) *citrina* (Benth.) Paul G.Wilson, Nuytsia 8: 407 (1992). | n/a | *Waitzia dasycarpa* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 77 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 65.*" | *Waitzia steetziana* Lehm.; Benth., Fl. Austral. 3: 636 (1867). |
| *Rhodanthe* (sect. ***Helipteridium***) *heterantha* (Turcz.) Paul G. Wilson, Nuytsia 8: 412 (1992). | *Helipterum discoideum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 231 (Aug. 1852). (In sect. ***Helipteridium*** A.Gray). Type: "Variat α, involucro pallido; β, involucro sanguineo. Swan River (β, Swan River to King George's Sound), *Drummond*." | *Helipterum heteranthum* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 198 (27 March 1851). Type: "Nova Hollandia. *Drum. IV. n. 214.*" | *Helipterum heteranthum* Turcz.; Benth., Fl. Austral. 3: 642 (1867). |
| *Rhodanthe* (sect. *Leiochrysum*) *chlorocephala* (Turcz.) Paul G.Wilson, Nuytsia 8: 386 (1992). [Gray's var. ß belongs to subsp. *chlorocephala*, var. α to subsp. *rosea* (Hook.) Paul G.Wilson.] | ***Acroclinium** *multicaule* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 271 (Sept. 1852), as to var. β. Type: "Variat α, radiis involucri lacteis; β, radiis involucri flavescentibus et subæruginosis. Swan River, *Drummond*." | *Schoenia chlorocephala* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 193 (27 March 1851). Type: "Nova Hollandia. *Drum. IV. n. 199.*" | *Helipterum chlorocephalum* (Turcz.) Benth., Fl. Austral. 3: 641 (1867). |

| Current name | A. Gray | N. Turczaninow | G. Bentham |
|---|---|---|---|
| *Rhodanthe* (sect. *Leiochrysum*) *fuscescens* (Turcz.) Paul G.Wilson, Nuytsia 8: 394 (1992). | ****Acroclinium*** *phyllocephalum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 271 (Sept. 1852). Type: "South-west Australia, *Drummond* (received in 1850)." | *Helipterum fuscescens* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 80 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 64."* | *Podotheca fuscescens* (Turcz.) Benth., Fl. Austral. 3: 602 (1867). |
| *Rhodanthe* (sect. *Leiochrysum*) *pygmaea* (DC.) Paul G.Wilson, Nuytsia 8: 398 (1992). | *Pteropogon drummondii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 267 (Sept. 1852). (In sect. ***Facelioides*** A.Gray). Type: "Swan River, and interior of South-west Australia, *Drummond*, 1849." | n/a | *Helipterum pygmaeum* var. *occidentale* Benth., Fl. Austral. 3: 647 (1867). |
| *Rhodanthe* (sect. *Leiochrysum*) *rubella* (A.Gray) Paul G.Wilson, Nuytsia 8: 398 (1992). | ****Acroclinium*** *rubellum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 271 (Sept. 1852). Type: "Between Swan River and King George Sound, *Drummond*." | n/a | *Helipterum rubellum* (A.Gray) Benth., Fl. Austral. 3: 641 (1867). |
| *Schoenia* (***Xanthochrysum*** subgroup) *filifolia* (Turcz.) Paul G.Wilson, Nuytsia 8: 373 (1992). | *Helipterum tenellum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 231 (Aug. 1852), nom. illeg. non Turcz. (1851). (In sect. ***Geniosperma*** A.Gray.) Type: "Swan River, *Drummond*." | ****Xanthochrysum*** *filifolium* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 199, t. 4 (27 March 1851). Type: "Nova Hollandia. *Drum. III. n. 119."* | *Helichrysum filifolium* (Turcz.) F.Muell., *Fragm.* 3: 134 (1863); Benth., Fl. Austral. 3: 617 (1867). |
| *Siloxerus multiflorus* Nees; P.S.Short, *Austral. Syst. Bot. Soc. Newslett.* 78: 6–7 (1994). | ****Actinopappus*** *drummondii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 226 (Aug. 1852). Type" "Swan River, *Drummond*." | n/a | *Rutidosus pumilo* Benth., Fl. Austral. 3: 595 (1867). |
| *Siloxerus pygmaeus* (A.Gray) P.S.Short, Muelleria 4: 413 (1981). | ****Chamaesphaerion*** *pygmaeum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 177 (June 1851). Type: "South-western Australia, *Drummond*." "**Ic. Pl. tab. ined.**" | ****Gyrostephium*** *rhizocephalum* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 77 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 55."* | *Chthonocephalus pygmaeus* (A.Gray) Benth., Fl. Austral. 3: 582 (1867). |
| [M] ***Triptilodiscus*** *pygmaeus* Turcz. | ****Dimorpholepis*** *australis* A.Gray, Hooker's Icon. Pl. 9: t. 856 (Sept.–Nov. 1851, or later, see Wilson 1992b, Short 1995); Hooker's J. Bot. & Kew Gard. Misc. 4: 227 (Aug. 1852). Type: "South-western Australia, *Drummond*. Also in the interior of Eastern Australia, at Bathurst Plains, *Fraser*; and Nangers, *Captain McArthur*." | ****Triptilodiscus*** *pygmaeus* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 66 (Aug.–Oct. 1851). Type: "Nova Hollandia, *Drum. coll. V. n. 54*." | *Helipterum dimorpholepis* Benth., Fl. Austral. 3: 650 (1867), nom. illeg. |
| *Waitzia acuminata* Steetz var. acuminata; Paul G.Wilson, Nuytsia 8: 469 (1992). | n/a | *Waitzia discolor* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(1): 194 (27 March 1851). Type: "Nova Hollandia. *Drum. coll. IV. n. 198*." | *Waitzia corymbosa* J.C.Wendl.; Benth., Fl. Austral. 3: 635 (1867). |
| *Waitzia suaveolens* (Benth.) Druce var. *suaveolens*; Paul G.Wilson, Nuytsia 8: 473 (1992). | n/a | *Waitzia odontolepis* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 77 (Aug.–Oct. 1851). Type: "Nova Hollandia. *Drum. V. n. 382."* | *Waitzia nivea* (Lindl.) Benth., Fl. Austral. 3: 636 (1867). |

Underlined names being those used by Bentham and at variance with Gray's and/or Turczaninow's generic names.

* Indicates that the generic name as well as the specific epithet was new to science.

† Indicates that, although accepted here, the author believes that the species is likely to be ultimately placed in another genus.

Generic names in ***bold italic*** in both the 'A. Gray' and 'N. Turczaninow' columns indicate that it was a new name proposed by that author. In the 'Current name' column it indicates which of those names, if any, is currently accepted.

A superscript **M** or **D** in the 'Current names' column indicates that the genus is monotypic (**M**) or ditypic (**D**).


**Fig. 1. A *Blennospora drummondii***, granite outcrop, Salmon Gum to Peak Charles road, W.A. (*P.S. Short 2733*); **B *B. phlegmatocarpa***, near Hines Hill, W.A. (*P.S. Short 4447 et al.*). **C–E *Calocephalus* s.lat.**: **C *C. knappii***, Yannarie River crossing, North West Coastal Hwy, W.A. (*P.S. Short 4306*); **D *C. multiflorus***, c. 31 km N of Mt Magnet, W.A. (*P.S. Short 4212*); **E *C. platycephalus***, Finke River gorge between Palm Valley and Hermannsburg, N.T. (*P.S. Short 3140*). **F *Trichanthodium skirrophorum***, 36 km W of Mundrabilla, W.A. (*P.S. Short 3906*). — Photos: **A** B.A. Fuhrer; **B–F** P.S. Short.


**Fig. 2. A–C *Gnephosis* s.str.**: **A *G. cassiniana***, c. 10 km W of Pindar, W.A. (*P.S. Short 2881 et al.*); **B *G. tridens*** (tall narrow plant) & ***G. multiflora***, salt lake adjacent to Wave Rock, W.A. (*P.S. Short 4530* & *4531 et al.*); **C *G. trifida***, 5 km S of Morowa, W.A. (*P.S. Short 2971 et al.*). **D *Gnephosis* s.lat.**: ***G. setifera***, c. 7 km S of Bunjil (*P.S. Short 2955 et al.*). **E *Lemooria burkittii***, 26 km S of Leonora, W.A. (*P.S. Short 4390*). **F *Myriocephalus pygmaeus***, c. 31 km N of Mt Magnet, W.A. (*P.S. Short 4215*). — Photos: **A, C, D** B.A. Fuhrer; **B, E, F** P.S. Short.

**Key to genera which have been or are included in *Calocephalus* s.lat. and *Gnephosis* s.lat.** (see notes on p. 153)

**1**. Florets with a pappus of bristle or bristle-like elements
- **2.** Capitula solitary or few in terminal clusters, capitular bracts generally visible in all capitula . . . . . ***Gilruthia*** (p. 187)
- **2:** Capitula in compound heads, with perhaps the exception of outer capitula the capitular bracts substantially hidden
  - **3.** Coastal shrub with at least the upper leaves small and appressed, branches and leaves with a dense white to silvery tomentum, compound heads generally somewhat whitish in appearance except for the yellowish exposed florets (at least eastern Australian specimens commonly intricately branched and cushion-like; southern mainland Australia and Tas.) . . . . . ***Leucophyta*** (p. 207)
  - **3:** Non-coastal shrub, annual or perennial herbs or if shrub-like not with short, appressed upper leaves
    - **4.** Leaves mostly opposite (perennial herbs; cypsela base stipe-like, lacking an annular carpopodium) . . . . . ***Calocephalus* s.str.** (p. 166)
    - **4:** Leaves only or mostly alternate (2 or 4 lowermost leaves may be paired); cypsela base with or lacking an annular carpopodium
      - **5.** Receptacular bracts present, forming a central column of c. 5 bracts . . . . . ***Balladonia*** (p. 162)
      - **5:** Receptacular bracts absent
        - **6.** Cypsela not enveloped in a layer of mucilaginous cells, rarely appearing glabrous, scattered to dense, and often myxogenic, hairs usually present; annual or perennial herbs . . . . . ***Calocephalus* s.lat.** (p. 169)
        - **6:** Cypsela enveloped in a layer of myxogenic cells (appearing glabrous); annual herbs
          - **7.** Florets 1–3; capitular bracts lacking a distinctly demarcated terminal lamina (W.A., S.A., Vic.) . . . . . ***Blennospora*** (p. 164)
          - **7:** Florets c. 8–16; capitular bracts with a distinct claw and terminal lamina (W.A.) . . . . . ***Calocephalus* s.lat.** (p.p., ***C. multiflorus*** only) (p. 180)

**1:** Florets lacking a pappus or the pappus cup-like, or if with bristles or bristle-like elements then either a single bristle present (as in *Myriocephalus pygmaeus*, syn. *Gnephosis pygmaea*) or plants glabrous with flexuose stems (*G. acicularis*) or branches and leaves with scale-like hairs or/and each capitulum with a single capitulum-subtending bract, which is morphologically manifestly different from the upper leaves and the capitular bracts (forms of *G. tenuissima*)
- **8.** Capitula loosely crowded towards the end of major axes but remaining distinct and not forming a compound head (the outer involucral bracts of all capitula readily visible); capitula heterogamous, florets female and male (W.A.) . . . . . ***Notisia*** (p. 210)
- **8:** Capitula not distinct, forming a compound head (the outer involucral bracts of inner capitula substantially hidden and not visible without dissection of the compound head); capitula usually homogamous (florets all bisexual), only heterogamous in *Stuartina*
  - **9.** Capitular bracts with the inner 2 or 3 with rigid, recuved apices [annual herb with prostrate or weakly erect branches 3–30 cm long; leaves spathulate; capitula heterogamous, with outer filiform florets and bisexual disc florets] (W.A., S.A., Qld, N.S.W., A.C.T., Vic.) . . . . . ***Stuartina muelleri*** (syn.: *Gnephosis rotundifolia*)
  - **9:** Capitular bracts not with rigid recurved apices; capitula homogamous
    - **10.** Branches and leaves beset with stiff, erect bristles (south-western W.A., probably confined to Monger Drainage System) . . . . . ***Gnephosis* s.lat.** (p.p., ***G. setifera*** only) (p. 207)
    - **10:** Branches and leaves glabrous or variably hairy but lacking bristles
      - **11.** Plants usually with scale-like glandular hairs on major axes and leaves, if absent (*G. cassiniana*) or seemingly so then each capitulum subtended by a single broad bract, the bract manifestly different in morphology from the capitular bracts; compound heads in some species narrowly oblong to cylindrical . . . . . ***Gnephosis* s.str.** (p. 189)
      - **11:** Plants lacking scale-like glandular hairs on major axes and leaves; capitulum-subtending bract absent or if 1 or more present then not manifestly differing from outer capitular bracts; compound heads never cylindrical
        - **12.** Cypselas narrowly ellipsoid or narrowly cylindrical, with scattered, non-myxogenic, straight twin hairs and an annular carpopodium; pappus a single bristle or rarely absent [plants consisting of a single compound head and appearing stemless or with prostrate to ascending major axes; leaves linear or subterete; compound heads with a well-developed involucre; florets (1) 2–4 (6) per capitulum; corolla 3- or 4-lobed] (W.A.) . . . . . ***Myriocephalus pygmaeus*** (syn. *Gnephosis pygmaea*)
        - **12:** Cypselas and pappus (if present) not as above
          - **13.** Branches prostrate, wiry, reddish and each terminating in a compound head with a general involucre of 12–18 densely lanate bracts, these bracts basally with wing-like, hyaline margins; florets 1 or 2; pappus of 8–12 subplumose bristles about ½ the length of the corolla tube (semi-arid and arid regions of W.A., S.A., Qld, N.S.W., Vic.) . . . . . ***Lemooria burkittii*** (syn.: *Gnephosis burkittii*)
          - **13:** Not with the above combination of characters
            - **14.** Capitula at least 2-flowered . . . . . ***Gnephosis* s.lat.** (p. 195)
            - **14:** Capitula 1-flowered
              - **15.** Cypselas with a layer of myxogenic cells covering the entire surface, lacking hairs (W.A., N.T., S.A., Qld, N.S.W., Vic.) . . . . . ***Trichanthodium*** (p. 211)
              - **15:** Cypselas with eglandular hairs . . . . . ***Gnephosis* s.lat.** (p. 195)

## Taxonomy

***Balladonia* P.S.Short, *gen. nov.***

**Type:** *B. aervoides* (F.Muell.) P.S.Short

Annual *herbs,* each major branch terminating in 1–several compound heads, all branches with long, septate hairs, the lower part of the hairs flat and c. 0.1 mm wide, the upper half flagellate. *Leaves* alternate, the lower ones always or often with petiolate-like bases (and manifestly so in *B. aervoides*) but the uppermost commonly lacking them, lamina entire, with an indumentum of septate hairs resembling those of the major axes. *Compound heads* with or without a conspicuous involucre of leaf-like bracts. *Capitula* 5–40 per compound head, homogamous. *Capitular bracts* in 2 rows, not differentiated into a distinct claw and terminal lamina; some outer bracts may be foliaceous with narrow hyaline margins (*B. aervoides*), otherwise bracts essentially hyaline except for the midrib; outer bracts with long, intertwined hairs mainly extending from the margins; inner bracts glabrous or sparsely hairy. *Receptacular bracts* present, the c. 5 bracts are joined at least at the base and form a central column, with 5 florets peripheral to the column, and one in the centre of the column, the bracts each with a dense vestiture of long, intertwined hairs at the apex. *Florets* 6, bisexual, yellowish. *Corolla* 5-lobed; lobes with slightly thickened margins and (perhaps not in all lobes) densely papillate on c. the lower ⅓ of the inner surface; inner epidermal cells of lobes with straight to undulate walls, cells of the tube tending to be longer or much longer and their walls straight to undulate; vascular strands in the tube 5, each not extending to a sinus between two lobes. *Stamens* 5; anthers not or barely caudate; apical appendages somewhat triangular; filament collar more or less straight in outline or gradually and slightly dilating along its length towards the base. *Style* with 2 distinct vascular traces from the base, a small nectary present at the base, apices penicillate. *Cypselas* monomorphic, obovoid or somewhat subtriquetrous, papillate, the papillae being subglobose, myxogenic twin hairs, a dense aggregation of large, somewhat rectangular crystals at and about the apex visible in cleared fruit; pericarp with 2 vascular bundles; carpopodium annular, whitish. *Pappus* of scale-like, white bristles joined at the base and c. ½ the length of the corolla tube, each bristle with long, intertwined marginal hairs. *Chromosome numbers*: unknown.

*Distribution*. A ditypic genus, with both species endemic to Western Australia.

*Etymology*. The name is derived from the locality, Balladonia Homestead, from which the type of *B. multiceps* was collected.

*Notes*. As previously indicated (Short 1990b) *Calocephalus aervoides* and *Chthonocephalus multiceps* J.H. Willis should be referred to a separate genus. The most distinctive, and unique, feature is the united column of receptacular bracts at the centre of the receptacle. Five florets are arranged peripherally, another is located in the centre of the column.

At least the lowermost leaves of both species are described here as having petiole-like bases rather than being petiolate, the midrib always having at least a narrow wing and dilating near the base. Thus, I consider them to be sessile, as is usual in the tribe.

**Key to species of *Balladonia***

**1.** Major axes ascending to erect; compound heads usually several together in an elongate spike, subtending leaf-like bracts absent or only 1 or 2 present .... **1. *B. aervoides***

**1:** Major axes prostrate; compound heads surrounded by 5 or 6 leaf-like bracts ..... **2. *B. multiceps***

**1. *Balladonia aervoides* (F.Muell.) P.S.Short, *comb. nov.***

*Pachysurus aervoides* F.Muell., Fragm. 3: 154 (1863) (basionym). — *Calocephalus aervoides* (F.Muell.) Benth., Fl. Austral. 3: 576 (1867) ("*aeruoides*"); Grieve & Blackall, How Know W. Austral. Wildfl. 823 (1975) ("*aeruoides*"). — *Leucophyta aervoides* (F.Muell.) Kuntze, Revis. Gen. Pl. 1: 352 (1891) ("*aeruodes*"). — **Type citation:** "Ad portum Gregorii. A. Oldfield." **Lectotype (here designated):** Port Gregory, *A. Oldfield* (MEL 543268). **Isolectotype:** PERTH. **Probable isolectotype:** K 000901839. (See notes below).

Annual *herb*, major branches ascending to erect, 4–36 cm long and terminating in 1–several compound heads. *Leaves* with often petiole-like bases but the uppermost often sessile, crisped, lamina of the smaller ones often elliptic or ovate, of the largest irregularly ovate or rhomboid, total leaf 3.5–60 mm long, 1.4–40 mm wide, indumentum sparse to dense. *Compound heads* very broadly to depressed ovoid, 4–7 mm long, 5–7 mm diam., often 2–5 loosely arranged in a spike; general involucre absent or sometimes with 1 or 2 (?several) leaf-like bracts at the base, usually much shorter than the compound heads. *Capitula* c. 7–10. *Capitular bracts* with the outer ones oblanceolate, 1.7–2 mm long, 0.4–0.6 mm wide, mainly foliaceous but with narrow hyaline margins, or mainly hyaline, always with long, intertwined hairs mainly extending from the margins; inner bracts obovate, 2.4–2.7 mm long, 1.1–1.4 mm wide, mainly hyaline, glabrous or sparsely hairy. *Corolla* with the lobes with slightly thickened margins and (perhaps not in all lobes) densely papillate on c. the lower ⅓ of the inner surface; tube 1.25–1.9 mm long; inner epidermal cells of lobes with straight to undulate walls, cells of the tube tending to be longer and their walls straight to undulate; vascular tissue not extending to the base of the lobes. *Stamens* 5; anthers c. 0.9 mm long, microsporangia c. 0.65–0.7 mm long, apical appendages somewhat triangular, c. 0.19–0.25 mm long, tail absent; filament collar c. 0.1 mm long, gradually dilating along its length towards the base. *Cypselas* obovoid, 0.8–1 mm long, 0.5–0.6 mm diam., body dark brown, minutely papillate; carpopodium 0.06–0.1 mm long. *Pappus* of c. 12 scale-like bristles.

*Distribution*. Apart from the type collection, gathered in the vicinity of Port Gregory, the species is not known from the mainland. Other collections have been gathered from Dorre Island and islands that comprise Houtman Abrolhos.

*Habitat*. Collectors' notes record little, if any, information on the habitat of this species but it has been noted as growing in calcareous sand or sandy loam.

*Phenology & reproductive biology*. Recorded flowering from about mid-August to early October.

A pollen:ovule ratio of 3,380 was determined for a single floret removed from *A.S. Weston 10463*, from Dorre Island.

*Typification.* The MEL type specimen of *Pachysurus aervoides* is a sheet containing two elements, one being a large part of a plant with the main root attached, the other a smallish branch which, as indicated by scarring near the base, was removed from the larger element. The sheet also has three labels, one in ink with "Pt. Gregory/W.A./Oldf.", another in pencil with "416/ Moist places near Yanginooka (South)", while the third is a blue "Botanical Museum of Melbourne" label giving the name of the species but no locality; all three labels are mounted in a line along the right-hand side of the sheet. A sheet at K also contains two elements and again there is reference to both Yanginooka (South) and Port Gregory, while on the original MEL label accompanying the fragmentary PERTH collection the locality is merely recorded as Pt Gregory. I have no doubt that all elements are of syntype material seen by Mueller when naming *Pachysurus aervoides* and that all are of the one taxon. I am also of the opinion that they are likely to be from the one gathering, with Yanginooka (South) being the actual locality from which the specimen was collected but, as it was nearby and a location with which readers were likely to be familiar, the place name Port Gregory was cited in the protologue. I am inclined to this view because similar discrepancies between label data and the locality cited in publication are not unusual in the case of names published by Mueller. However, although I believe the two elements on the MEL specimen are from the one plant there must be some doubt, however minor, that the K specimen is from the same gathering. I have therefore chosen the MEL specimen as the lectotype of the name *P. aervoides*, regard the PERTH specimen as an isolectotype, and consider the K specimen to be a probable isolectotype.

*Notes*. Outer capitula in some compound heads may have a poorly developed column of receptacular bracts and fewer than six florets.

There is considerable variation in habit and leaf size in this species, e.g. the lectotype specimen and those gathered from Dorre Island are much more robust than those from the Houtman Abrolhos. Habitat notes are generally lacking from labels but I suspect that environmental factors, such as the degree of exposure to wind, account for most of the variation.

Anthers in this species appear to lack tails whereas in *B. multiceps* they are present, albeit very fine and quite short (c. 0.15 mm long). However, with only several florets examined for both species this observation may prove unreliable.

*Additional specimens examined.*

Western Australia: East Wallabi Is., 3 Oct. 1987, *J.J. Alford 657* (PERTH); West Wallabi Is., Sep. 1959, *M. Gilham Herb. 2935* (PERTH); North Is., Houtmans Abrolhos, Sep. 1959, *M. Gilham* (PERTH); North Is., Houtman Abrolhos, *M. Gilham Herb. 2186* (PERTH); White Beach, Dorre Island, 6 Oct. 1975, *K.F. Kenneally 4612* (PERTH); West Wallabi Is., Sep. 1959, *G.M. Storr Herb. 3529* (PERTH); East Wallabi Is., 8 Oct. 1969, *G.M. Storr Herb. 3587* (PERTH); White Beach, Dorre Is., 13 Aug. 1977, *A.S. Weston 10463* (PERTH).

**2. *Balladonia multiceps* (J.H.Willis) P.S.Short, *comb. nov.***

*Chthonocephalus multiceps* J.H.Willis, Proc. Roy. Soc. Queensl. 62: 105, pl. 7, figs 25–33 (1952), basionym. — **Type citation:** "... Balladonia Homestead, 128 miles east of Norseman, on sandy soil against large granite slabs, with ephemeral *Helipterum* spp., etc., 31st August, 1947, *J.H. Willis*, Grimwade Expedition. (holotype in MEL, paratype in PERTH, clastotype in BRI)." **Holotype:** MEL 542225. **Isotypes:** BRI AQ0332363, NSW 587970, ?PERTH (see note below).

Annual *herb* with prostrate major branches to c. 15 cm long and terminating in 1 or 2 compound heads. *Leaves* with the lower ones often shortly petiolate, the upper ones sessile, all entire, spathulate or oblanceolate, 10–32 mm long, 3–9 mm wide, indumentum sparse to dense. *Compound heads* broadly to broadly depressed ovoid, 4.5–7.5 mm long, 5.5–9 mm diam., usually terminal on well-developed axes but usually one almost sessile and immediately above the root; general involucre of c. 5 or 6 leaf-like bracts c. ⅔ to twice the length of the heads. *Capitula* c. 5–40. *Capitular bracts* mainly hyaline except for a prominent, opaque midrib extending for c. ⅔ the length; outer bracts c. 6, oblanceolate, 2.2–2.7 mm long, 0.4–0.8 mm wide, with long intertwined hairs mainly extending from the margins; inner bracts c. 6, obovate, 2.2–2.5 mm long, 1–1.2 mm wide, glabrous or sparsely hairy. *Corolla* with the lobes with slightly thick margins and (perhaps not in all lobes) densely papillate on c. the lower ⅓ of the inner surface; tube 1.25–1.9 mm long; inner epidermal cells of lobes with straight to undulate walls, cells of the tube much longer and with undulate walls; vascular tissue not or barely extending to the base of the lobes. *Stamens* 5; anthers 0.8–0.88 mm long, microsporangia 0.67–0.7 mm long, apical appendages somewhat triangular, 0.17–0.21 mm long, tail c. 0.15 mm long; filament collar 0.15–0.2 mm long, more or less straight in outline or gradually and slightly dilating along its length towards the base. *Cypselas* obovoid and sometimes somewhat subtriquetrous (but if so, perhaps infertile), 0.8–0.9 mm long, c. 0.3–0.4 mm diam., body darkish grey or greyish purple,

densely papillose; carpopodium 0.06–0.08 mm long, c. 5 or 6 cells high. *Pappus* of c. 9 or 10 scale-like bristles.

*Distribution*. Western Australia, from Balladonia to Cape Arid.

*Habitat*. I have not seen this species in the field. The few collectors' notes regarding it habitat indicate an association with granite, i.e. "*Eucalyptus occidentalis* woodland, edges granitic sheet, surface calcareous loam, subsurface granite" and "granitic loamy sand".

*Phenology & reproductive biology*. Recorded flowering in September/October.

A pollen:ovule ratio of 2,418 was determined for a single floret removed from *P.G. Wilson 2880*, from c. 100 km S of Balladonia.

*Typification*. In his original description Willis indicated that there is a "paratype" in PERTH and a "clastotype in BRI". I have no record of having seen the former specimen but may have done when revising *Chthonocephalus* (Short 1990b). Note that from the protologue it is apparent that specimens referred to as being a clastotype and a paratype are from the same gathering as the holotype specimen and are therefore the equivalent of isotypes. Taxonomists such as Willis (e.g. 1952) and Davis (1948) adopted a different terminology to that in current use, following, for example, Davis & Lee (1944) and references therein. For them, once the holotype was selected a paratype would be another plant from the original gathering; a clastotype was probably a piece removed from the holotype specimen.

*Note*. Willis (*J.H. Willis*: CANB 136758, MEL 85303, PERTH) recorded that the plant has "pleasantly fragrant flower heads — spicy-aromatic with caramel ("burnt sugar") overtones".

*Additional specimens examined.*

Western Australia: Junana Rock, Cape Arid N.P., 28 Oct. 1989, *G.J. Keighery 11889* (PERTH); 21 km ESE of Boingaring Rocks, 11 Sep. 1980, *K. Newbey 7287* (PERTH); Balladonia, 6 Sep. 1963, *J.H. Willis* (CANB 136758, MEL 85303, PERTH); c. 100 km S of Balladonia, 10 Sep. 1964, *P.G. Wilson 2880* (AD).

## Blennospora A.Gray

Hook. J. Bot. & Kew Gard. Misc. 3: 98, 172 (1851); P.S. Short, Muelleria 6: 349–358 (1987); A.Anderb., Opera Bot. 104: 130 (1991); P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 809 (1999); Keighery, Nuytsia 15: 33–36 (2002); R.J.Bayer et al. in Kadereit & C.Jeffrey (eds), Fam. Gen. Vasc. Pl. 8: 258 (2006). — **Type:** *B. drummondii* A.Gray

[*Calocephalus* auct. non. R.Br. (1817): Benth., Fl. Austral. 3: 573 (1867); various State floras.]

Annual *herbs*, cottony. *Leaves* with at least the lowest pair(s) opposite, the upper and often most alternate but at least in *B. doliifromis* probably all opposite, all leaves sessile, entire, erect, mucronate, cottony, uppermost often with hyaline apices. *Compound heads* with a general involucre, the bracts leaf-like or hyaline except for the midrib and somewhat flat or curved, *not* forming a claw with a distinct terminal lamina; general receptacle with shortly pedunculate capitula scattered along a single hairy axis. *Capitula* (2) 5–30 per compound head. *Capitular bracts* in 2 or 3 somewhat distinct rows, mostly hyaline except for an opaque midrib extending most of its length and not forming a manifestly, morphologically distinct claw and terminal lamina; mid to upper margins shortly ciliate or with long hairs; bracts commonly united by tangled long hairs. *Florets* 1–3, bisexual; corolla tubular, (4) 5-lobed, tube yellow, lobes yellow or purplish black. *Style branches* truncate, with short sweeping hairs. *Stamens* (4) 5; anthers with a sterile, narrowly triangular apical appendage; microsporangia tailed, endothecial tissue polarized; filament collar straight in outline and composed of uniform cells, basally not thicker than the filament. *Cypselas* monomorphic, obovoid, brown; pericarp with mucilaginous cells covering the surface, vascular bundles 2; carpopodium annular. *Pappus* of multiseriate, unequal, flexible, irregularly long-ciliate bristles joined at the base, longest elements about the length of the corolla tube. *Chromosome number*: $2n = 22$.

*Distribution*. Southern mainland Australia, with all three species in W.A. and only *B. drummondii* extending to the eastern States.

*Reproductive biology*. High pollen:ovule ratios, and showy, strong-smelling florets suggest that *B. phlegmatocarpa* has a high degree of cross-pollination while the low pollen:ovule ratios and less showy, not obviously scented florets of *B. doliiformis* and *B. drummondii* are indicative of them having high levels of self-pollination and being self-compatible.

*Etymology*. From the Greek *blennos* (mucilage or slime) and *spora* (seed), in reference to the single-seeded fruit with a pericarp composed of a layer of cells which become mucilaginous on wetting. With the transfer of *Calocephalus phlegmatocarpus* to *Blennospora*, both the generic name and the specific epithet of the resulting binomial have the same meaning, the epithet derived from the Greek prefix *phlegmato-* , meaning mucus, while *carpos* is the Greek word for fruit.

*Notes*. Short (1987a) recognised two species, *B. drummondii* and *B. phlegmatocarpa*, with Keighery (2002) subsequently describing a new species, *B. doliiformis*, of which the earliest herbarium specimen was apparently collected in November 1987.

### Key to the species of *Blennospora*

**1.** Corolla lobes purplish black (W.A., S.A., Vic.) . . . . . **3. *B. drummondii***

**1:** Corolla lobes yellow (but may dry brown) (W.A. only)

**2.** Compound heads barrel-shaped; flowers not obviously aromatic; leaves probably opposite thoughout . . . . . **2. *B. doliiformis***

**2:** Compound heads ellipsoid to broadly ellipsoid or ovoid to broadly ovoid; flowers manifestly aromatic; leaves variably opposite or alternate . . **1. *B. phlegmatocarpa***

**1. *Blennospora phlegmatocarpa* (Diels) P.S.Short**

Muelleria 4: 413 (1981); P.S.Short, Muelleria 6: 354 (1987, fig. 2.). — *Calocephalus phelgmatocarpus* Diels, Bot. Jarb. 35: 614, fig. 69 o–u (1905). — **Type citation:** "Hab. in distr. Avon pr. Wyola in lutosis gregaria flor. m. Oct. (D. 5020)." **Lectotype:** Wyola, W.A., 24 Oct. 1901, *L. Diels 5020* (MEL 543205) (Short 1987a, p. 354). **Probable isolectotype:** East of York, *L. Diels* (PERTH 04370678).

*Calocephalus stowardii* S.Moore, J. Linn. Soc., Bot. 45: 182 (1920). — **Type citation:** "Cowcowing; *Stoward*, 485." **Lectotype:** Cowcowing, W.A., 1916, *F. Stoward 485* (BM 000810544) (Short 1987a, p. 355).

Ascending to erect *herb* to 10 cm tall. *Leaves* opposite to alternate, semi-terete to terete or linear to narrowly oblanceolate, often somewhat succulent, erect, 5–27 mm long, 0.5–1.5 mm wide, mucronate, cottony, the uppermost ones with hyaline apices and merging in appearance with the bracts of the general involucre. *Compound head* ellipsoid to broadly ellipsoid or ovoid to broadly ovoid, 6–10 mm long, 4.5–10 mm diam.; general involucral bracts leaf-like or somewhat resembling the capitular bracts. *Capitula* c. 5–20 per compound head. *Outer capitular bracts* obovate to oblanceolate or elliptic, 1.7–3.2 mm long, 0.4–1.7 mm wide, flat to conduplicate, outer surface often with long hairs at or about the apex of the midrib, bracts united by long hairs along the mid and upper hyaline margins. *Inner capitular bracts* elliptic or ovate, 2.3–2.8 mm long, 1–1.5 mm wide, flat to conduplicate, outer surface with long hairs at or about the apex of the midrib, margins entire or with long hairs which usually unite the bracts. *Florets* 1–3 per capitulum; corolla tube 5-lobed, lobes yellow. *Stamens* 5; anthers 0.9–1.33 mm long. *Cypselas* 0.9–1.1 mm long. *Pappus bristles* 6–10. *Chromosome number*: $2n = 22$. **Fig. 1B.**

*Distribution*. Common in south-western Western Australia.

*Habitat*. Mostly found on saline, often sandy soils on the margins of salt lakes and commonly associated with *Atriplex*, *Disphyma* and *Tecticornia*. A few collections have been made from apparently non-saline soils in *Eucalyptus* woodland.

*Phenology and reproductive biology*. Flowering & fruiting from about September to December.

Compound heads are showy and have a strong aroma, and pollen:ovule ratios ranging from 2,525 to 6,119 have been recorded (Short 1981a, b, 1987a).

*Cytology*. Short (1981b, 1987a) recorded $2n = 22$ for a population (*P.S. Short 633*) on the southern margins of Lake Brown, W.A.

*Notes*. When flowering, plants have a strong, almost putrid, odour. It is a feature evident in herbarium specimens at least 30 years old, not just fresh specimens, and readily distinguishes this species from its congeners.

*Selected specimens examined.*

Western Australia: W side of Lake Gounter, 10 Nov. 1978, *R.J. Chinnock 4339* (AD, MEL); Mortlock River flats, 22 Oct. 1945, *C.A. Gardner* (PERTH 494879); Kevills Lake, 11 Nov. 1983, *L. Haegi 2639* (MEL); salt flats at Hines Hill, 21 Sep. 1977, *P.S. Short 619* (AD); S margins of Lake Brown, 22 Sep. 1977, *P.S. Short 633* (AD); S edge of Lake Varley, 11 Sep. 1982, *P.S. Short 1694* (MEL).

**2. *Blennospora doliiformis* Keighery**

Nuytsia 15: 33 (2002). — **Type citation:** "Ruabon Nature Reserve, 33°39'S, 115°30'E, Western Australia, 3 November 1993, *G.J. Keighery* 12931 (*holo:* PERTH 00363369)."

Erect *herb* to 15 cm tall; stem usually simple with 1 or 2 branches at upper nodes; cottony but becoming glabrous. *Leaves* opposite (perhaps with the exception of the uppermost 1 or 2 leaves), erect, semi-terete to terete, linear, often soft and somewhat succulent, erect, 5–15 mm long, 0.5–0.8 mm wide, mucronate, cottony, the uppermost leaves never overtopping flowering compound heads (rarely one almost level). *Compound heads* barrel-shaped, flat at summit, 6–9 mm long, 4–6 mm diam.; general involucral bracts with 1-several somewhat leaf-like but mostly pale brown, hyaline except for the midrib, at least part of their margins commonly with long hairs. *Outer capitular bracts* hyaline, somewhat elliptic to narrowly elliptic, 2–3.5 mm long, 0.5–1.1 mm wide, almost flat to conduplicate, outer surface with long hairs at or about the apex of the midrib, bracts united by long hairs along the upper margins; inner bracts elliptic or obovate, 3.8–4.5 mm long, 1.6–2.2 mm wide, outer surface with long hairs at or about the apex of the midrib, with long hairs on the upper magins. *Florets* (1) 2 (3?) per capitulum; corolla tube 4- or 5-lobed, golden yellow (drying brown). *Stamens* 5; anthers 0.49–0.75 mm long; microsporangia 0.3–0.5 mm long; terminal appendage 0.21–0.28 mm long. *Cypselas* obovoid, 1.35–1.6 mm long, 0.8–1.0 mm diam., dark brown. *Pappus bristles* 5–8. *Chromosome number*: unknown.

*Distribution*. South-western Western Australia; Gingin to Busselton on the Swan Coastal Plain and on the Scott Coastal Plain.

*Habitat*. Found on clay soils under *Melaleuca cuticularis* low woodland, in *Melaleuca uncinata*/*M. viminea* shrubland, *Banksia* (*Dryandra*) *squarrosa* shrubland, and in lateritic heath.

*Phenology and reproductive biology*. Flowers in October–November, mature fruit c. December to March.

Compound heads are not particular showy, lack any recorded aroma, and have 4- or 5-lobed florets. Florets sometimes have only four anthers and anthers have microsporangia only 0.3–0.5 mm long. Pollen:ovule ratios determined for seven individual florets (taken from two compound heads) of *G.J. Keighery 2433*, collected from near Capel, W.A., ranged from just 272 to 480 ($\bar{x} = 363.1$; s.d. = 68.77; s.e. = 28.076).

*Notes*. Probably most likely to be confused with *B. drummondii*, the visible corolla lobes drying brown and in general appearance the plants reminiscent in habit of that species, and some W.A. specimens determined as *B. drummondiii* prior to 2002 being *B. doliiformis*. The presence of probably totally opposite leaves, the flat-topped, barrel-shaped compound heads, and the yellow florets readily distinguish it from that species.

*Selected specimens examined.*

Western Australia: Fish Road Nature Res., 14 Oct. 1992, *B.J. Keighery & N. Gibson 010* (PERTH); Austin Bay Nature Res., 29 Oct. 1993, *B.J. Keighery & N. Gibson 021* (PERTH); Lake Muckinburra Res., 27 Oct. 1993, *B.J. Keighery & N. Gibson 026* (PERTH); c. 5 km E of Ludlow, 5 March 2001, *G.J. Keighery 16076* (PERTH); Scott N.P., 34° 17'S, 115° 15'E, 1 Nov. 1990, *C.J. Robinson 300* (PERTH).

### 3. *Blennospora drummondii* A.Gray

Hook. J. Bot. & Kew Gard. Misc. 3: 173 (1851); P.S.Short, Muelleria 6: 355 (1987). — *Calocephalus drummondii* (A.Gray) Benth., Fl. Austral. 3: 574 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 821 (1975); P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 809, fig. 162c (1999); Corrick & Fuhrer, Wildfl. Victoria, pl. 38 (2000). — *Leucophyta drummondii* (A.Gray) Kuntze, Revis. Gen. Pl. 1: 352 (1891). — **Type citation:** "Swan River, *Drummond*." **Lectotype:** Swan River, *J. Drummond* (K 000901825) (Short 1987a, p. 356). **Probable isolectotypes:** *J. Drummond 359* (BM 000810545; G 00222878; GH (A 00004250, ex BM); MEL 543273; P 00715973, annotated as *nov. gen.* by Gray, no specific epithet; P 00715972, ex BM). **Remaining syntypes & isosyntypes:** *J. Drummond 68* (E 00385951, K 000901824).

Ascending to erect *herb* to 10 cm tall. *Leaves* mostly alternate, semi-terete to terete or linear to narrowly oblanceolate, often slightly succulent, erect, 5–25 mm long, 0.5–1 mm wide, mucronate, cottony, the uppermost usually overtopping the compound head. *Compound head* ellipsoid to broadly ellipsoid or ovoid to broadly ovoid, 6–12 mm long, 4–13 mm diam.; general involucral bracts somewhat resembling the capitular bracts, mainly hyaline except for the opaque midrib, glabrous to densely hairy on the outersurface. *Capitula* 2–30 per compound head. *Outer capitular bracts* obovate to spathulate, sometimes almost elliptic, 1.7–3.5 mm long, 0.7–1.5 mm wide, flat to conduplicate, outer surface usually with long hairs at or about the apex of the midrib and the bracts united by the hairs, the upper hyaline margins variably ciliate. *Inner capitular bracts* elliptic or ovate to lanceolate, 1.8–4 mm long, 1.7–3.5 mm wide, conduplicate, outer surface with long hairs at or about the apex of the midrib and the bracts free or united by the hairs, upper margins entire or ciliate. *Florets* 1–3 per capitulum; corolla tube 4- or 5-lobed, lobes purplish black. *Stamens* 4 or 5; anthers 0.45–0.75 mm long. *Cypselas* 1.1–1.4 mm long. *Pappus bristles* 7 or 8. *Chromosome number*: $2n = 22$. **Fig. 1A.**

*Distribution*. Widespread in south-western Western Australia, southern South Australia and western Victoria.

*Habitat*. Grows in an array of habitats, including in *Eucalyptus* woodland, in mossy swards over granite and in loam over limestone in mallee-eucalypt associations. It is seemingly less tolerant to salt than *B. phlegmatocarpa* but has been found growing on the upper margins of the samphire zone of some salt lakes.

*Phenology and reproductive biology*. Flowering from about late August, fruiting about November.

The non-showy inflorescence and its lack of a strong aroma, and pollen:ovule ratios ranging from 64 to 339 (Short 1981a, b, 1987a) indicate that it, as also speculated with *B. doliiformis*, commonly self-pollinates and is likely self compatible.

*Cytology*. Short (1981a, b, 1987a) recorded $2n = 22$ for populations from near Dalwallinu, W.A. (*P.S. Short 595*) and Port Julia, S.A. (*P.S. Short 719*).

*Notes*. The inconspicuous, purplish black corolla lobes readily distinguish this species from its congeners.

*Selected specimens examined.*

Western Australia: Purnta Rock, 26 Sep. 1977, *P.S. Short 683* (AD); c. 9.4 km from the Great Northern Hwy along road to Perenjori, 2 Sep. 1982, *P.S. Short 1628* (MEL); W edge of Lake King, 11 Sep. 1982, *P.S. Short 1680* (MEL); 65 km SW of Sandstone, 26 Aug. 1970, *P.G. Wilson 8889* (PERTH).

South Australia: 6 km SW of Port Julia, 17 Dec. 1977, *P.S. Short 719* (AD).

Victoria: c. 24 km SW of Nhill, 4 Oct. 1980, *P.S. Short 1219 & M.G. Corrick* (MEL).

### *Calocephalus* R.Br. s.str.

Trans. Linn. Soc. London 12: 106 (25 Feb. 1818; as preprint before Sep. 1817); R.Br., J. Phys. Chim. Hist. Nat. Arts 86: 409 (1818); R.Br., Verm. Bot. Schr. 2: 545 (1826); DC., Prodr. 6: 151 (1838); P.S.Short, Muelleria 6: 349–358 (1987). — **Lectotype:** *C. citreus* Less. (Anderberg 1991, p. 131).

Perennial *herbs*, major axes ascending to erect, hairy, at least the upper part of each axis somewhat angular, each major axis commonly branching. *Leaves* entire, sessile, entirely or predominantly opposite and the uppermost ones sometimes alternate, tomentose, the midrib and often two lateral veins prominent, uppermost leaves may have a small hyaline appendage at the apex. *Compound heads* spheroidal to broadly ellipsoid or oblong or broadly depressed ovoid to ovoid; general involucre absent; general receptacle cylindrical to narrowly oblong, consisting of a single, hairy major axis with the capitula scattered more or less evenly along its entire length. *Capitula* 20–300. *Capitular bracts* 8–16, flat to conduplicate, arranged in c. 3 whorls with the outer bracts the smallest, obovate to oblanceolate or somewhat elliptic, mainly hyaline and tending to form a morphologically distinct claw and terminal lamina, although the terminal lamina may be more distinguished by being yellow or white and opaque rather than colourless and transparent; claw glabrous or with long hairs extending from the hyaline margins and/or near the apex of the midrib; midrib opaque, brown to green,

extending c. ½–⅓ the total length of the bract. *Florets* 2 or 3. *Corolla* 5-lobed; lobes with slightly thick margins, much of the inner surface papillate (only glabrous near the apex) with papillae extending along the vascular strands in the tube; inner epidermal cells of lobes and tube with straight or almost straight margins, cells of the lobe smaller; vascular strands seemingly extending to the base of the lobes but obscured by papillae. *Style* with 2 distinct vascular traces from the base, nectary present, branches truncate, apices papillate. *Stamens* 5; anthers caudate, each with a somewhat widely deltate to triangular apical appendage; filament collar more or less straight in outline. *Cypselas* monomorphic, subobconic, brown, epidermis with globose myxogenic twin-hairs which lack basal cells; pericarp lacking sclerenchyma (*C. citreus*, *P.S. Short 855*; *C. lacteus*, *A. Opie 29*); vascular bundles in pericarp 2; carpopodium absent, the abscission area not differentiated from the pedicel. *Pappus* of 4–11 multiseriate bristles which are plumose in the upper part and united at the base into a small ring. *Chromosome number*: *n* = 28.

*Distribution*. South-eastern Australia, below an arc extending from south-eastern Queensland to southern Eyre Peninsula in South Australia and including Tasmania.

*Etymology*. From the Greek *kalos* (beautiful) and *kephale* (head), in reference to the appearance of the compound head.

*Notes*. As indicated above, this genus was first described by Robert Brown (1817) in a paper titled "Observations on the natural family of plants called Compositae …". This same paper was translated into French by Cassini, with additional notes by both Brown and Cassini, and the original was also included by Nees von Esenbeck in a five-volume collection of Brown's publications, i.e. *Robert Brown's Vermischte botanische Schriften*. I have not seen the latter publication, details of which are provided by Stafleu & Cowan (1976–1988), and it is this publication to which Lessing referred in his treatment of both *Calocephalus* and *Leucophyta*.

Fruit of both species are illustrated in Short (1987a, fig. 2), being compared with that of *Blennospora phlegmatocarpa*.

**Key to species of *Calocephalus* s.str.**

**1.** Capitular bracts yellow; leaves mostly wider in lower half . . . . . **1. *C. citreus***

**1:** Capitular bracts white; leaves mostly wider in upper half . . . . . **2. *C. lacteus***

**1. *Calocephalus citreus* Less.**

Syn. Gen. Compos. 271 (1832); Brongn. in Duperrey, Voy. Monde, pl. 60, fig. A (?1832–1834), n.v., as cited in DC.; DC., Prodr. 6: 151 (1838); Sond., Linnaea 25: 491 (1853); Benth., Fl. Austral. 3: 575 (1867); F.M. Bailey, Queensl. Fl. 850 (1900); C.Moore & Betche, Handb. Fl. New South Wales 289 (1893); J.M.Black, Fl. S. Austral. 1st ed. 648 (1929), 2nd ed. 928 (1957); W.M.Curtis, Stud. Fl. Tasman. 346 (1963); N.T.Burb. & M.Gray, Fl. A.C.T. 389, fig. 389 (1970); J.H.Willis, Handb. Pl. Victoria 2: 732 (1973); P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1502 (1986); Stanley in Stanley & Ross, Fl. S.E. Queensl. 2: 546 (1986); P.S.Short, Muelleria 6: 351, fig. 3a (1987); E.A.Brown in G.J.Harden, Fl. New South Wales 3: 259 (1992); P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 811, fig. 162d (1999). — *Calocephalus lessingii* F.Muell., Key Vict. Pl. 1: 332 (1888), nom. illeg. — *Leucophyta citrea* (Less.) Kuntze, Revis. Gen. Pl. 352 (1891), nom. illeg., non *L. citrea* Sond. (1853). — *Calocephalus lessingii* F.Muell. f. *citreus* (Less.) F.Muell. ex Maiden & Betche, Census N.S.W. Pl. 200 (1916). — *Leucophyta lessingii* (F.Muell.) F.Muell., Victorian Naturalist 9: 187 (1893), nom. illeg. — **Type citation:** "Herbae Novae Hollandiae." **Syntypes:** ?CW, see notes below for possible syntypes or isosyntypes.

Perennial *herb*; major branches erect, c. 15–60 cm long, extending from basal nodes, often developing minor shoots; major and minor branches somewhat rounded to angular, hairy. *Leaves* lanceolate or sublinear, 10–110 mm long, 1–2 mm wide, tomentose, often sheathing at the base, the midrib and often two lateral veins prominent. *Compound heads* spheroidal to broadly ellipsoid or oblong or broadly depressed ovoid to ovoid, 4–20 mm long, 5–9 mm diam. *Capitula* c. 30–300 per compound head. *Capitular bracts* 8–11, more or less obovate to oblanceolate or somewhat elliptic, sometimes abruptly attenuated in c. the lower ⅓, mainly colourless and hyaline but the terminal lamina yellow, and with an opaque brown or green midrib which extends c. ½–⅓ the length of the bract, glabrous or with long hairs extending from near the apex of the midrib, all bracts flat to conduplicate, 1.9–3.4 mm long, 0.5–0.9 mm wide, arranged in 2 or 3 rows with the outermost bracts the smallest. *Corolla* tube 1.5–2 mm long. *Style* branches c. 0.5 mm long. *Stamens* with anthers c. 1–1.1 mm long; microsporangia c. 0.8–0.85 mm long; apical appendages triangular, c. 0.2–0.27 mm long. *Cypselas* subobconic, 0.7–0.85 mm long, c. 0.5 mm diam. *Pappus* of 4–9 bristles. *Chromosome number*: *n* = 28.

*Distribution*. Occurs in south-eastern Australia, below an arc extending from south-eastern Queensland to southern Eyre Peninsula and including Tasmania.

*Habitat*. Grows in loam and clayey soils in woodlands, grasslands and herb fields. Collectors' notes include: "*Eucalyptus leucoxylon* association", "Peppermint Gum woodland. Brown loam", "Amongst grasses and weeds on roadside ... basalt", and "Common in low-lying, open area dominated by *Craspedia globosa* [*Pycnosorus globosus*] and mixed grasses."

*Phenology & reproductive biology*. Flowering occurs from about September to March.

A pollen:ovule ratio of 2,862 was determined for a single floret from *M.G. Corrick* (MEL 1575899), a specimen from the vicinity of Skipton, Victoria.

Schaumann et al. (1987) noted that seed sowed in autumn germinated in 6 to 14 days; no provenance was stated.

*Cytology*. Watanabe et al. (1999) recorded *n* = 28 for a population (*P.S. Short 4573*) at Derrimut Grasslands

above the northern edge of Andersons Swamp near Melbourne; one or two quadrivalents were sometimes present.

*Typification*. I have not seen any specimens annotated by Lessing, the principal locality of his herbarium and types apparently being CW (Stafleu & Cowan 1976–1988), and he gave no indication as to what he examined when describing this species. As Lessing made reference to Brown's earlier publication it seem highly likely that he had one or more of Brown's specimens before him when describing and naming them. However, as others had also collected this species prior to Lessing's publication, it cannot be assumed that this scenario is correct. For example, I have seen specimens in P collected by Brown *and* some attributed to the voyage of d'Urville, the latter presumably collected during his expedition of 1826–1829. Of these various specimens I noted a sheet (P 00716004, ex herb. Drake) labelled as "Calocephalus (aureus) ... Compositae p. 106". The label was almost certainly not in Brown's hand but, on the same label and in a different hand, it has "Communicavit R. Brown". Another P sheet (P 00716005) was annotated as having been received from K in 1884 and labelled, possibly in Brown's hand, as "Calocephalus citreus Less. V. Diemen's Land". I also saw three further sheets in P (P 00716001, P 00716002, P 00716003), these being received from E in 1890 and simply noted as being from Brown's Iter Australiensis 1802–05. Identically labelled specimen are in E and NY (NY 00163019). I tentatively labelled all five of the aforementioned P specimens as "possible syntypes or isosyntypes" of the name *C. citreus*. Of the two sheets of this species in P which are attributed to the voyage of d'Urville the locality given for both is Port Jackson, both have reference to the numbers "83 & 253", and one sheet is labelled as "ex herb. Schultz-Bip." (P 03312994), the other as "ex herb. Roussel" (P 03312995). I labelled neither of these collections as possible syntypes or isosyntypes but they are within the time-frame for Lessing to have seen collections from that voyage. I also note that, of the two specimens of this species cited by Candolle (1838) and held at G-DC — as per no. 1037 of the microfiche of the *Candolle Prodromus Herbarium, Genève* — one is attributed to "Port Jackson/ M. D'Urville 1826". The other specimen cited by Candolle was collected by Allan Cunningham in May 1817 from the Lachlan River; it may reflect the quality of the reproduction but I am not totally convinced that it is of this species.

Assuming that Lessing viewed a specimen, or specimens, collected by Brown the following held at, or on loan to, MEL in June 1991 and gathered from Tasmania may be isotypes or isosyntypes of specimens examined by Lessing: Derwent River between Risdon Cove & Frederick Hentry [sic] Bay [original label with "Van Diemanens Land" (Stearn 1962)] (CANB 279089); V. Diemen's Land (BRI 224115); Van Diemens Land (MEL 85014); no locality but with Bennett 2142 label (MEL 85010).

All of the above specimens attributed to Brown and d'Urville and referred to above are of the same taxon. Despite the uncertainty as to the type status of these specimens adequate referencing and clear descriptions by Lessing (1832) and others such as Candolle (1838) and Bentham (1867a), as well as references by both Candolle and Bentham to the illustration in the *Atlas* of Duperrey's *Voyage autour du monde*, give no reason to doubt that the name *Calocephalus citreus* is correctly applied.

*Notes*. The name *Calocephalus lessingii* is a nomenclatural synonym and was coined by Mueller (1888) as a result of his belief that *C. citreus* and *C. lacteus* are conspecific.

*Selected specimens examined.*

South Australia: Bool Lagoon, 29 Dec. 1961, *D. Hunt 615* (AD); Belair, 4 Dec. 1937, *E.H. Ising* (AD 97649918); Tarnma, 4 Feb. 1969, *D.N. Kraehenbuehl 2523* (AD).

Queensland: between Wallangarra and Bald Mtn, 16 Jan. 1933, *S.T. Blake 4498* (BRI).

New South Wales: about 4 miles north of Armidale, 9 Jan. 1944, *G.L. Davis* (NSW 138941); 8 miles S of Goulburn, 22 Jan. 1968, *I. Beeton* (CBG 022565); Ginninderra to Gundaroo road, 18 Feb. 1976, *J.M. Taylor 139* (CBG).

Australian Capital Territory: Canberra, 14 Jan. 1950, *E. Gauba* (CBG 015418).

Victoria: E of Skipton on Glenelg Hwy, Nov. 1968, *M.G. Corrick* (MEL 1575899); Werribee, 7 Jan. 1893, *A. Morrison* (BRI 086219, CANB 133548).

Tasmania: Derwent River between Risdon Cove and Frederick Hentry [sic] Bay, 1804, *R. Brown* (CANB 279089); Bridgewater, 5 Mar. 1945, *W.M. Curtis* (MEL 621562).

**2. *Calocephalus lacteus* Less.**

Syn. Gen. Compos. 271 (1832); Brongn. in Duperrey, Voy. Monde, pl. 60, fig. B (?1832–1834), n.v., as cited in DC.; DC., Prodr. 6: 151 (1838); Schltdl., Linnaea 20: 591 (1847); Hook.f., Fl. Tasman. 1: 196 (1860); Benth., Fl. Austral. 3: 575 (1867); J.M.Black, Fl. S. Austral. 1st ed. 648 (1929), 2nd ed. 928 (1957); W.M.Curtis, Stud. Fl. Tasman. 345 (1963); J.H.Willis, Handb. Pl. Victoria 2: 732 (1973); P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1503 (1986); P.S.Short, Muelleria 6: 351, fig. 3c–e (1987); P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 811, fig. 162e (1999). — *Calocephalus lessingii* F.Muell., Key Vict. Pl. 1: 332 (1888), nom. illeg. — *Leucophyta lactea* (Less.) Kuntze, Revis. Gen. Pl. 352 (1891). — *Leucophyta lessingii* (F.Muell.) F.Muell., Victorian Naturalist 9: 187 (1893), nom. illeg.; Bot. Centralbl. 54: 221 (1893). — *Calocephalus lessingii* F.Muell. f. *lacteus* (Less.) Maiden & Betche, Census N.S.W. Pl. 200 (1916). —**Type citation:** "Herbae Novae Hollandiae." **Syntypes:** ?CW, none seen. See note below.

Perennial *herb*, major branches ascending, 5–70 cm long, hairy, mainly rounded but the upper part of each branch somewhat angular, each major branch commonly branching. *Leaves* usually obovate to oblanceolate, sometimes narrowly elliptic or linear, 10–50 mm long, 1–4.5 mm wide, tomentose, often sheathing at the base, rounded at the apex, the midrib and often two lateral veins prominent, uppermost leaves often with a

small hyaline appendage at the apex. *Compound heads* spheroidal to broadly ellipsoid or oblong or ovoid, 6–15 mm long, 6–9 mm wide. *Capitula* 20–200. *Capitular bracts* 9–16, obovate to oblanceolate, mainly colourless and hyaline but the terminal lamina white and opaque, with an opaque brown to green midrib which extends c. ½ the length of the bract, glabrous or with long hairs extending from the hyaline margins and near the apex of the midrib, all bracts flat to conduplicate, 1.5–3.3 mm long, 0.6–1.2 mm wide, arranged in c. 3 whorls with the outer bracts the smallest. *Corolla* tube 1.1–2 mm long. *Style* branches c. 0.6–0.75 mm long. *Stamens* with anthers c. 0.9–1 mm long; microsporangia c. 0.72–0.77 mm long; apical appendages widely deltate to triangular, c. 0.2–0.25 mm long. *Cypselas* subobconic, 1–1.1 mm long, c. 0.4 mm diam. *Pappus* of 6–11 bristles. *Chromosome number*: unknown.

*Distribution*. Occurs in the southern Mt Lofty Ranges and south-eastern South Australia, much of southern Victoria, the south-eastern corner of New South Wales, and Tasmania.

There is a record of this species for Western Australia, it being a specimen attributed to James Drummond (*J. Drummond 3*: *118*) and one widely distributed in herbaria, e.g. E, MEL, NSW & P. During his third collecting expedition Drummond travelled from Toodyay to Albany and east to Cape Riche and, given that *C. lacteus* is known from near-coastal habitats in eastern Australia, it is not inconceivable that he did collect it. However, unless it was extremely rare, a lack of subsequent collections from W.A. strongly suggests that *J. Drummond 118* comes from elsewhere and, as he didn't venture outside that State, was not collected by Drummond. In the absence of subsequent specimens I believe it should not be recorded for W.A.

*Habitat*. Collectors' notes include: "Coastal cliffs. Associated species include *Stipa teretifolia* [*Austrostipa stipoides*], *Poa poiformis*, *Calocephalus* [*Leucophyta*] *brownii*, *Carpobrotus rossii*, *Lobelia alata* [*L. anceps*], *Apium prostratum*.", "amongst grasses and weeds on roadside. Hard caked soil. Basalt.", "Organic clay loam to 4 cm over light clay ... Continuous grassland, cleared. Associated with *Phalaris tuberosa*, *Plantago varia*, *Poa* sp., *Plantago lanceolata*, *Cirsium vulgare*, *Juncus* sp.", "among *Typha angustifolia* in shallow moist depression in quarry", "Under *Eucalyptus ovata* at edge of grassy flat" and "partially cleared dry sclerophyll ... on bare ground".

*Phenology & reproductive biology*. Flowering mainly occurs from about November to March.

A single floret from *A. Brown 168* (MEL), collected from the vicinity of Forest Lagoon, Tasmania, contained 3,314 pollen grains.

*Typification*. As with *C. citreus* it seems likely that Lessing examined a specimen or specimens collected by Robert Brown from Tasmania. If so, CANB 279090, K 000901833, MEL 543203, MEL 543204, NSW 139006 and P 00715999 are presumably syntypes or isosyntypes of the name *C. lacteus*. Both MEL 543204 and P 00715999 are annotated, possibly in Brown's hand, as "Calocephalus lacteus Less." As with *C. citreus*, there may be other specimens which were examined by Lessing, such as a gathering from Western Port Bay attributed to d'Urville and cited by Candolle (1838). However, again as with *C. citreus*, there seems no reason to believe, whatever proves to be authentic type material, that there is any problem with the current application of the name *C. lacteus*.

*Notes*. The name *Calocephalus lessingii* is an illegitimate name and a nomenclatural synonym, being coined by Mueller (1888) as a result of his belief that *C. citreus* and *C. lacteus* are conspecific.

*Selected specimens examined.*

South Australia: Onkaparinga River at Grünthal [= Verdun], 1 Mar. 1884, *Anon.* (AD 97622638, ex herb. R. Tate); Bool Lagoon, 29 Dec. 1961, *D. Hunt 614* (AD).

New South Wales: Northern shores of Baragoot Lake, May 1995, *J. Miles* (NSW 392139, number as per plantnet. rbgsyd.nsw.gov.au, accessed August 2012).

Victoria: 6.5 km from Newhaven, coastal cliffs, 4 Feb. 1984, *D.E. Albrecht 182* (MEL); Cape Woolamai, Phillip Is., 8 Sep. 1981, *A. Opie & S. van Berkel 29* (MEL); Hawkesdale, Jan. 1903, *H.B. Williamson* (NSW 139012).

Tasmania: Verwood Rd, Forest Lagoon, 27 Jan. 1981, *A. Brown 168* (BRI, HO, MEL); between Steppes and Interlaken, 28 Jan. 1949, *N.T. Burbidge 3431* (AD, CANB); River Jordan, Jan. 1900, *F.A. Rodway* (NSW 139008).

### *Calocephalus* R.Br. s.lat.

*Calocephalus* s.lat.: Benth., Fl. Austral. 3: 573 (1867) p.p., excluding *Blennospora*, *Leucophyta*, *C. citreus* & *C. lacteus*; O.Hoffm. in Engler & Prantl, Nat. Pflanzenfam. IV(5): 194 (1890) p.p., excluding *Blennospora*, *Leucophyta*, *C. citreus* & *C. lacteus*; P.S.Short in Jessop, Fl. Centr. Austral. 391 (1981); P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1501 (1986), p.p., excluding *Leucophyta*, *C. citreus* & *C. lacteus*; A.Anderb., Opera Bot. 104: 128 (1991) p.p., excluding *C. citreus* and *C. lacteus*; R.J.Bayer et al. in Kadereit & C.Jeffrey, Fam. Gen. Vasc. Pl. 8: 270 (2006) p.p., excluding *C. citreus* & *C. lacteus*.

*Achrysum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 228 (Aug. 1852). — **Type:** *A. glomeratum* A.Gray

*Notes*. I believe it likely that all species included here will at some stage be removed from *Calocephalus* and referred to other genera, some new and perhaps with the name *Achrysum* reinstated. However, in the meantime I accept them all as members of *Calocephalus*.

*Calocephalus birchii*, *C. glabratus*, *C. multiflorus* and *C. pilbarensis* have morphological attributes which suggest that each is well-removed from all others included here but there are some species which share a number of features suggesting a close relationship. Thus, *C. beardii* and *C. knappii* are generally similar in gross morphology and are anatomically united in that the base of the corolla lobes are papillose. Similarly, *C. badmanii* and *C. platycephalus* share many features

**Key to species included in *Calocephalus* s.lat.**

**1.** Robust herb or subshrub, branches and leaves almost glabrous except for occasional long, septate eglandular hairs, but compound heads with a manifestly woolly/cottony general involucre of bracts, each of the inner bracts with a white lamina (south-western Qld) ..... **5. *C. glabratus***

**1:** Herb or subshrub but at least lacking the general involucre as above

**2.** Perennial, robust subshrub with linear leaves 15–65 mm long, 0.5–1 mm wide, branches and leaves with a dense, whitish grey, cottony indumentum contrasting with dark yellow compound heads which are ovoid or ellipsoid, 10–20 mm long; outer capitular bracts subcartilaginous and compound heads difficult to pull apart (central Qld) ..... **3. *C. birchii***

**2:** Perennial or annual plants unlike the above, never with subcartilaginous bracts

**3.** Cypselas lacking an annular carpopodium, the abscission area not differentiated from the pedicel (annual herbs, capitular bracts with yellow or white terminal laminae; cypselas beset with small, glistening globose, myxogenic hairs; eastern mainland Australia: S.A., Qld, N.S.W., Vic.) ..... **10. *C. sonderi***

**3:** Cypselas with an annular carpopodium

**4.** Cypsela enveloped in a layer of myxogenic cells (appearing glabrous); annual herbs ..... **7. *C. multiflorus***

**4:** Cypsela not enveloped in a layer of mucilaginous cells, rarely appearing glabrous, scattered to dense (and often myxogenic) hairs usually present; annual or perennial herbs

**5.** Cypselas sericeous, i.e. enveloped with long, straight hairs (W.A.) ..... **8. *C. pilbarensis***

**5:** Cypselas never enveloped in long, straight hairs but usually with scattered globose twin-hairs

**6**. Base of corolla lobes papillose; inner epidermal cells of the corolla throat with undulate margins

**7.** Pappus of 6 or 7 bristles which are plumose throughout their length and have a terminal tuft; leaves, with the exception of the uppermost ones, glabrous or only with short glandular hairs (W.A.) ..... **2. *C. beardii***

**7:** Pappus of 3–6 lax, plumose bristles; leaves mostly with a conspicuous cottony indumentum (W.A., N.T., S.A., Qld) ..... **6. *C. knappii***

**6:** Base of corolla lobes not papillose; inner epidermal cells of the corolla throat with straight margins

**8.** Branches mostly glabrous or only with scattered hairs, if at all dense then only beneath the compound heads (weakish herbs; bracts subtending the compound heads absent; capitular bracts each with a 0.6–1.1 mm long, reflexed, yellow or rarely white terminal lamina; W.A.) ... **4. *C. francisii***

**8:** Branches mostly with a dense cottony or silky indumentum

**9.** Branches rigid, erect usually with a dense cover of long, silky, white, appressed hairs, sometimes somewhat cottony; pappus of 11–16 sub-flexuose bristles (mound springs, S.A., ?Qld) ..... **1. *C. badmanii***

**9:** Branches ascending to erect, usually not rigid, with a sparse to dense cottony indumentum; pappus of 6–11 flexuose bristles (W.A., N.T., S.A., Qld, N.S.W.) ..... **9. *C. platycephalus***

in common and *C. francisii* — which is otherwise distinctive — may not be far removed from them, all three species lacking basally papillose corolla lobes.

**1. *Calocephalus badmanii* P.S.Short, *sp. nov.***

**Type:** South Australia. 67 km S of William Creek, South Australia, 1 Nov. 1989, *B. Nordenstam & A. Anderberg 975* (holotype: MEL 1591937; isotypes: AD n.v., E 00433318, MO 797777, NSW n.v., NY 00004656, PERTH n.v., S (two sheets, S-G-114 & S09-35337).

[*Calocephalus platycephalus* auct. non (F.Muell.) Benth.; P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1504, fig. 681B (1986), p.p.; P.S.Short in Jessop, Fl. Centr. Austral. 392 (1981), p.p.]

[*Calocephalus dittrichii* auctt. non F.Muell.; J.M.Black, Trans. & Proc. Roy. Soc. South Austral. 42: 57, fig. 8 (1918), Fl. S. Austral. 1st ed. 648, pl. 54 (1929), 2nd ed. 929, fig. 1231 (1957).]

*Subshrub*, c. 30–60 cm tall, major branches somewhat rigid, mainly erect, usually with a dense cover of long, silky, white, appressed hairs, sometimes somewhat cottony. *Leaves* alternate, sessile, entire, more or less linear or lanceolate, the upper part usually recurved, 4–15 mm long, 0.5–1.5 mm wide, with silky, white appressed hairs or somewhat cottony, uppermost leaves often with a small hyaline apex. *Compound heads* somewhat globular or obloid, c. 4–14 mm long, 4–14 mm diam.; bracts subtending compound heads generally resembling the outer capitular bracts but the midrib more prominent, the entire surface of the midrib cottony; *general receptacle* branched, sparsely cottony. *Capitula* c. 20–40 per compound head. *Capitular bracts* in more or less 2 rows. *Outer bracts* c. 8–10, hyaline except for a midrib extending c. the length of the claw, all bracts united by long intertwined hairs at the apex of the midrib; claw narrowly elliptic or oblanceolate to obovate, 2.2–2.8 mm long, 0.7–1.2 mm wide; terminal lamina very widely depressed to depressed ovate, 0.5–0.9 mm long, 0.7–0.95 mm wide, more or less distinguished by a constriction above the midrib, yellow. *Inner bracts* c. 7–9, hyaline, midrib indistinct, extending c. 4/5 the length of the bract, all bracts elliptic or obovate, 3.2–3.5 mm long, 1–1.2 mm wide, glabrous, apex pale yellow, a terminal lamina not differentiated or if so then smaller than in the outer bracts. *Partial receptacle* conical, glabrous. *Florets* 8–28, bisexual. *Corolla* tubular, 5-lobed; lobes with thick margins and apparently lacking papillae on inner surface; tube 2–3 mm long; inner epidermal cells of lobes and throat with straight walls, the cells not in distinct rows; vascular strands not extending the length of the tube. *Style* with 2 distinct vascular traces from the base, nectary annular,


**Fig. 3.** Holotype of ***Calocephalus badmanii*** (MEL). — *B. Nordenstam & A. Anderberg 975.*


**Fig. 4.** Holotype of ***Calocephalus beardii*** (MEL). — *P.S. Short 4238.*

branches truncate, 0.54–0.8 mm long, apices papillate. *Stamens* 5; anthers c. 1 mm long, prominently caudate, each with a subtriangular (somewhat straight-sided in the lower half) apical appendage c. 0.2–0.25 mm long; filament collar c. 0.3 mm long, more or less straight in outline but gradually dilating towards the base. *Cypselas* 0.7–0.8 mm long, c. 0.4 mm diam., brown, with globose (?myxogenic) twin hairs which seemingly lack basal cells; vascular bundles in pericarp 2; carpopodium annular. *Pappus* of 11–16, sub-flexuose bristles about the length of the corolla, joined at the base, bristles long-plumose throughout their length, with a pale yellow terminal tuft. *Chromosome number*: unknown. **Fig. 3.**

*Distribution*. Apparently restricted to north-eastern South Australia between latitudes c. 29° and 30°S and longitudes *c*. 136° and 140°E.

*Habitat*. Locality notes accompanying specimens indicate that *C. badmanii* is restricted to mound spring areas, referring to the plants growing in saline soils in the vicinity of the springs but also growing in the surrounding, dry, limestone mounds. Collectors' notes include: "on rocky outcrop in yellow gravelly sand", "sandy slightly saline area, occasionally flooded", "mound springs (margins) in travertine limestone with yellow sand", "on floodplain in yellow saline sand", and "in more or less saline, sandy flat".

*Phenology& reproductive biology*. Flowering collections having been gathered from July to February, with most (five) collected in July.

A pollen:ovule ratio of 3,258 was determined for a single floret removed from *F.J. Badman 3004*, a specimen from Finniss Springs Station.

*Etymology*. The name honours the collector and ecologist, Frank Badman (1943–2015) (Barker et al. 2016).

*Notes*. Distinguished from *C. platycephalus* by its habit and the number of pappus bristles (11–16 per floret compared with 6–11 in *C. platycephalus*). The long-plumose teeth of the pappus bristles also tend to be more spreading in *C. badmanii* than in *C. platycephalus*.

Black (1918) applied the name *Calocephalus dittrichii* F.Muell. to this species following advice from A.J. Ewart that Gill's specimen from Coward Springs agreed well with the type specimen in MEL.

*Additional specimens examined.*

South Australia: Hamilton Hill, *Anon. 26* (AD 9782 3007); Hill at Smith Springs 80 km W of Marree, 3 July 1989, *F.J. Badman 2958* (AD); Sulphuric Springs, Finniss Springs Stn, 9 July 1989, *F.J. Badman 3004* (AD); Old Finniss Springs, 9 July 1989, *F.J. Badman 3011* (AD); Horse Springs, Stuart Ck Stn, 12 July 1989, *F.J. Badman 3088* (AD); 5 km SE of Beresford, 22 Jan. 1989, *R. Bates 17185* (MEL); at 12 Springs, Moolawatana Stn, 29 Aug. 1972, *B. Copley 3823*; Gosse Springs, 11 July 1983, *T.J. Fatchen 609* (AD); Coward Springs Mound, 19 Nov. 1891, *W. Gill* (AD 97632046, ex herb. Black; MEL 85028); Near Catt's Springs on Murnpeowie, Sep. 1898, *M. Koch 2027* (AD ex herb. J.M. Black, BRI, MEL, NSW); Near Petermorra Springs, 31 Feb. 1984, *N. McLaren 42* (AD); Hamilton Hill, 19 Oct. 1983, *M. Nobbs 1214* (AD); William Ck, 19 Sep. 1984, *M. Nobbs 1298* (AD); Finniss Springs, 13 Dec. 1926, *F.D. Warren ?10* (AD 97649466; AD 97632045, ex herb. Black; AD 97632046, ex herb. Black); 10 km W of Curdimurka, 3 Oct. 1978, *J.Z. Weber 5777* (AD).

**2. *Calocephalus beardii* P.S.Short, *sp. nov.***

**Type:** Western Australia. 4.5 km S of turn-off to Neds Ck and Wiluna along Great Northern Highway (25°26'35"S, 119°17'01"E), 26 Aug. 1995, *P.S. Short 4238* (holotype: MEL 2027650; isotypes: AD, K, PERTH).

*Calocephalus* aff. *knappii* (F.Muell.) Ewart & Jean White; P.S.Short in Jessop, Fl. Centr. Austral. 391 (1981).

*Calocephalus* sp. Pilbara-Desert (*M.E. Trudgen 11454*) WA Herbarium, as per florabase.dec.wa.gov.au/ [pre March 2012], and www.anbg.gov.au/cgi-bin/apclist [accessed 7 Mar. 2012].

Annual *herb*, major branches 4.5–20 cm long, ascending to erect, mainly with shortly stalked glandular hairs, but often cottony below the compound heads. *Leaves* alternate, sessile, entire, lanceolate or linear, 4.5–32 mm long, 0.5–2.5 mm wide, the margins and midvein on the lower surface often thickened, the apex often bulbous, glabrous or with shortly stalked glandular hairs, usually the uppermost leaves cottony. *Compound heads* elliptic to spheroidal or broadly to very broadly ovoid, 7–23 mm long, 7–11 mm diam.; bracts subtending compound heads absent but the lowest capitula subtended by a single, mainly foliaceous, densely hairy bract; *general receptacle* branched, densely cottony, each secondary peduncle terminating in c. 2–4 capitula. *Capitula* c. 15–100 per compound head, each capitulum or secondary group apparently subtended by a densely cottony bract, the lower capitulum-subtending bracts mainly foliaceous, the upper resembling the outer capitulum bracts. *Capitular bracts* in 2 rows. *Outer bracts* c. 6, 2.9–3.9 mm long, 0.8–1.1 mm wide, hyaline except for a green midrib extending for c. the length of the claw, all bracts united by long intertwined hairs which invest the upper part of the midrib; claw somewhat elliptic or oblong, 2.4–2.7 mm long, 0.8–1 mm wide, hyaline margins entire; terminal lamina more or less lanceolate, c. 0.6–0.7 mm long, c. 0.25–0.3 mm wide, pale yellow. *Inner bracts* c. 8, 2.5–3.5 mm long, 0.9–1.5 mm wide, all bracts united by intertwined hairs at the apex of the midrib, the hairs shorter than in the outer bracts; claw ovate, 2.1–2.8 mm long, 0.9–1.5 mm wide, hyaline margins entire; terminal lamina ovate to very widely ovate, 0.3–0.7 mm long, c. 0.3 mm wide, flat to concave, barely reflexed, pale yellow. *Partial receptacle* conical, glabrous. *Florets* 8–39, bisexual. *Corolla* tubular, 5-lobed; lobes with slightly thick margins, inner surface papillate at the base; tube 1.9–2.2 mm long; inner epidermal cells of lobes and throat with more or less straight walls, tending to be slightly undulate in the throat, the cells not in distinct rows; vascular tissue not extending to the base of the sinus. *Style* with 2 distinct vascular traces from the base, nectary small, branches truncate, c. 0.55–0.8 mm long, apices papillate. *Stamens*

5; anthers c. 0.8–0.94 mm long, caudate; microsporangia c. 0.62–0.8 mm long; apical appendage triangular, c. 0.13–0.23 mm long; filament collar more or less straight in outline but slightly dilated towards the base. *Cypselas* (mature) not seen, seemingly glabrous and probably enveloped with myxogenic hairs; vascular bundles in pericarp 2; carpopodium annular. *Pappus* of 6 or 7 bristles c. the length of the corolla, joined at the base, bristles more or less evenly plumose throughout their length but with pale yellow terminal tufts. *Chromosome number*: unknown. **Fig. 4.**

*Distribution*. A common species in north-western and central Western Australia, between latitudes c. 20º and 28º S, and west of longitude 126º E.

*Habitat*. A species occupying a variety of arid habitats, with collectors' notes including "growing on ironstone laterite with scattered *Eremophila*", "in red clay loam among mulga", "gibber plain, ironstone", "stony red sand slope", "on flats with *Aristida*", and "along river on sandy soil".

*Phenology & reproductive biology*. Herbarium specimens have been collected as early as June and August but few if any have florets which have reached anthesis, full-flowering specimens usually being collected from mid-August to November, with most specimens gathered in September.

Pollen:ovule ratios from a single floret taken from each of five individual plants of *P.S. Short 4238*, the type specimen, ranged from 1,627 to 2,578 ($\bar{x}$ = 2,157; s.d. = 360.491; s.e. = 180.246).

*Etymology*. The epithet honours Dr John Beard (1916–2011) who published a number of botanical works — in particular vegetation maps — which I found most useful when I commenced botanizing in Western Australia in the late 70s. He also wrote the book *Plant Life of Western Australia* (Beard 1990) which, when I delve into it, brings back pleasant memories of field trips.

*Notes*. Many specimens of *C. beardii* have been previously referred to either *C. francisii* or *C. knappii*. It is readily distinguished from *C. francisii* which has capitular bracts with much larger terminal lamina and glabrous, often somewhat succulent leaves. There is overlap in the distribution of both species but *C. francisii* is usually found to the south-west of the range of *C. beardii*. The basal part of the corolla lobes of *C. francisii* are also non-papillate; they are papillate in *C. beardii*, a feature also shared with *C. knappii*, the species to which it appears most closely affiliated.

As noted in the key, *C. knappii* and *C. beardii* differ in leaf indumentum and pappus morphology. They also differ in the partial receptacle, which in *C. knappii* has minute pedicels but is smooth in *C. beardii*, and in the capitular bracts, which in *C. beardii* lack hairs on the margins but in *C. knappii* have long marginal hairs.

*Calocephalus beardii* has been found growing with *C. knappii* (*H. Toelken 6353* & *6354*) and *C. multiflorus* (*R.J. Chinnock 4706* & *4707*).

*Selected specimens examined.*

Western Australia: 3 miles S of Meekatharra, 26 Oct. 1965, *J.V. Blockley 127* (KPBG); 32.9 km NW of Minga Bore, 17 Sep. 1979, *R.J. Chinnock 4706* (AD); 21 km NW of Ashburton Downs on the Kooline road, 9 Sep. 1986, *R.J. Chinnock 7055* (AD); 90 miles E of Meekatharra, 16 Oct. 1945, *C.A. Gardner 7881* (PERTH); Belele Stn, 20 Nov. 1965, *D.W. Goodall 3439* (PERTH); 16 miles S of Nullagine, Sep. 1971, *R. Mirrington 710922* (PERTH).

### 3. *Calocephalus birchii* P.S.Short, *sp. nov.*

**Type:** Queensland. Sumana, N. of Aramac, 22°17'58"S, 145°21'34"E, calcareous dunes, 20 July 2006, *R.J. Fensham 5544* (holotype: BRI AQ616220).

*Calocephalus* sp. Aramac (*R.J. Fensham 5270*).

Perennial *subshrub*; major branches ascending to erect, to c. 40 cm long, surfaces mostly obscured by a dense, whitish grey, cottony indumentum, the upper part of flowering branches almost leafless for c. ⅓–½ their length. *Leaves* alternate, sessile, spreading, entire, linear, (5–) 15–65 mm long, 0.5–1 mm wide, margins inrolled, with a dense cottony indumentum often obscuring all but the blunt mucro. *Compound heads* ovoid or ellipsoid, 10–20 mm long, 10–14 mm diam.; bracts subtending compound heads absent; *general receptacle* a glabrous, elongate major axis with very short secondary branches culminating in small groups of capitula, individual capitula directly attached to major axis also present. *Capitula* c. 20–100 or more per compound head. *Capitular bracts* c. 7–9 in c. 2 or 3 rows, the outer most slightly shorter than the inner; all bracts obovate–oblanceolate, c. 2.3–3.5 mm long, 0.7–1 mm wide, flat to slightly conduplicate and each with a distinct claw and terminal lamina; claw mostly herbaceous, brownish, particularly the outer ones stiff and subcartilaginous, the margins sometimes in the lower half of the claw very narrowly hyaline; terminal lamina not to distinctly dilated above the claw and somewhat ovate, c. 0.5 mm long, semi-transparent, very pale yellow or whitish, distinguished from the claw by a constriction above the midrib; all bracts usually with long hairs extending from the hyaline outer surface of the bracts in the vicinity of the claw/margin interface. *Partial receptacle* ill-defined, glabrous. *Florets* 2, bisexual. *Corolla* tubular, 5-lobed; tube 1.6–1.9 mm long; lobes 0.25–0.44 mm long, with thickish margins, inner surface papillate except for the uppermost part of the tip, the papillae extending slightly down along the vascular traces; inner epidermal cells of throat with straight walls; vascular tissue extending to about the base of the sinus, sometimes being slightly above it or slightly below. *Style* with 2 distinct vascular traces, the distance they extend into the branches obscured by uncleared substance, branches c. 0.6–mm long, apices somewhat truncate but not manifestly so and long-papillate. *Stamens* 5; anthers 1–1.3 mm long, caudate,


**Fig. 5.** Holotype of ***Calocephalus birchii*** (BRI). — *R.J. Fensham 5544.*


**Fig. 6.** Holotype of ***Calocephalus glabratus*** (BRI). — *E. Addicott CL4.*

microsporangia 0.8–0.9 mm long; apical appendages triangular, 0.18–0.23 mm long; filament collar more or less straight in outline. *Cypselas* obovoid, 1.3–1.4 mm long, 0.7–0.8 mm diam., brown, the epidermis with numerous globose, shiny, perhaps slightly stalked papillae (glands); pericarp with 2 vascular bundles; carpopodium apparently absent, the fruit on a short stipe. *Pappus* of highly-divided, scale-like, white or (at least in part) pale yellowish elements joined at the base and often about the length of the corolla tube but somewhat variable in length (including within a single floret), the individual elements manifestly dividing into long, tangling processes ("hairs"). *Chromosome number*: unknown. **Fig. 5.**

*Distribution*. Endemic to central Queensland, with all specimens from the Mitchell Pastoral District.

*Habitat*. Collectors' notes include "saline areas around areas of groundwater discharge", "calcareous dunes", "salty scalded areas" and "inland sand dune ... open shrubland of *Calocephalus*, *Myoporum* and *Sclerolaena*".

*Phenology*. Flowering specimens have been collected for most months from April to December.

*Etymology*. I have been aware of the existence of this species for many years but, until recently, had mostly poor or inadequate material on which to base a description. The epithet honours Charles Weldon de Burgh Birch, who in 1873 collected the first specimen known to me. For a brief biography of Birch see George (2009) and references therein. Among other things, Birch (1872) encouraged those who resided in the Queensland bush to contribute to our knowledge of Australian plants by sending specimens to Ferdinand Mueller in MEL.

*Notes*. Dried compound heads, due to the subcartilaginous nature and strong attachment of the outer capitular bracts to the general receptacle, are difficult to dissect, even after soaking in hot water and detergent for 24 hours; this alone is a feature which sets it apart from other species included here in a broadly-defined *Calocephalus*.

I have opted to refer to the stiff and subcartilaginous bracts as part of an outer whorl of the involucre of each capitulum although it may be that they are better interpreted as capitulum-subtending bracts.

At first observation the pappus appeared to consist of long-plumose bristles, but closer examination suggests that the individual elements making up the pappus are better described as highly divided scales, there being no distinct central axis as observed in bristles.

*Additional specimens examined.*

Queensland: Bowen Downs, 1873, *[C.W.] Birch* (MEL 84976); Geera, Dec. 1935, *S.T. Blake 10387* (CANB n.v., BRI, K n.v., MO n.v., US n.v., SP n.v., AAU n.v., CHR n.v.); Albion Vale, Oct. 1989, *R. Cheffins 388* (BRI 449698); Coreena, N. of Barcaldine, 10 Oct. 2005, *R.J. Fensham 5270* (BRI AQ610552); Edgbaston, 16 Apr. 2007, *R.J. Fensham 5696* (BRI AQ753413); Lake Huffer, 30 Nov. 1997, *E.J. Thompson MUT25 & D.J. Baumgartner* (BRI AQ573046).

**4. *Calocephalus francisii* (F.Muell.) Benth.**

Fl. Austral. 3: 576 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 822 (1975). — *Pachysurus francisii* F.Muell., Fragm. 3: 155 (1863). — *Leucophyta francisii* (F.Muell.) Kuntze, Revis. Gen. Pl. 1: 352 (1891). — **Type citation:** "Ad flumen Murchison River et sinum Champion Bay. A. Oldfield." **Lectotype (here designated):** Murchison River, *A.F. Oldfield* (MEL 543274). **Isolectotypes:** K 000901845, NSW 139000. **Remaining syntype:** Champion Bay, *Anon.* (MEL 543275, presumed here to have been gathered by Oldfield).

Annual *herb*; major branches decumbent to erect, c. 1–14 cm long, mainly glabrous but hairy towards the compound heads; stem often simple in the smaller plants, 1–6.5 cm high, but usually forming major branches at near-basal and upper nodes. *Leaves* alternate, sessile, entire, sublinear or narrowly elliptic or lanceolate, 5–25 mm long, 0.5–3 mm wide, often semi-succulent, glabrous. *Compound heads* usually present (depauperate plants sometimes with a single capitulum), narrowly ellipsoid to globose or narrowly oblong or ovoid, 5–27 mm long, 4–10 mm diam.; bracts subtending compound heads absent; *general receptacle* with distinct peduncles which are 1–2 mm long and either simple or branched, the entire receptacle loosely enveloped in long hairs. *Capitula* 15–60 per compound head. *Capitular bracts* in 2 or 3 rows, all mainly hyaline, yellow or white and differentiated into a distinct claw and terminal lamina, the claw with a variably distinct, opaque, green midrib. *Outer bracts* 4 or 5 in a single row, usually with smaller and less reflexed terminal laminae than those of the inner bracts; claw somewhat elliptic or obovate, 1.4–1.8 mm long, 0.8–0.9 mm wide, with long hairs on the middle and upper margins; terminal lamina widely to very widely ovate, concave, 0.6–1 mm long, 0.6–1 mm wide. *Inner bracts* 5–9 in 1 or 2 rows, with terminal laminae reflexed c. 90º to the claw; claw widely elliptic to circular or obovate to very widely obovate, 1.7–2.2 mm long, 1.5–2.2 mm wide, usually with long hairs on the upper margins; terminal lamina transversely elliptic or depressed ovate, somewhat concave, 0.8–1.1 mm long, 1.5–1.6 mm wide. *Receptacle* conical. *Florets* 8–20, bisexual. *Corolla* 5-lobed; lobes with slightly thick margins, inner surface lacking papillae at the base, tube 1.6–2.3 mm long; inner epidermal cells of lobes and tube similar, their margins more or less straight (not undulate); vascular tissue not extending to the base of the lobes. *Style* with 2 distinct vascular traces from the base, nectary small, branches truncate, c. 0.5 mm long, apices papillate (some cells long-papillate). *Stamens* 5; anthers 0.66–0.75 mm long, caudate; microsporangia 0.44–0.51 mm long; apical appendages narrowly triangular, 0.21–0.24 mm long; filament collar more or less straight in outline. *Cypselas* obovoid, 0.4–0.5 mm long, 0.28–0.32 mm diam., pale brown or pinkish-brown, glabrous or with globose twin-hairs which

may have basal cells; pericarp lacking sclerenchyma (*P.S. Short 2080*); vascular bundles in pericarp 2; carpopodium annular. *Pappus* of 4–6 plumose bristles c. the length of the floret and united at the base in a small ring. *Chromosome number*: *n* = c. 14.

*Distribution*. Restricted to Western Australia between c. 23° and 30° S and west of c. 122° E.

*Habitat*. A common component of coastal heath, this species is also widespread in open scrub or woodland of the interior and in favourable seasons is common in herb fields that develop on sand-dunes. Less commonly occurs amongst samphire, *Atriplex* and *Frankenia* shrubs on the edge of saline depressions.

*Phenology & reproductive biology*. Flowering specimens have been mainly collected from about mid-August to mid-October.

The showy inflorescence alone suggests that this species must commonly cross-pollinate. This is supported by the pollen:ovule ratios determined for 15 individuals of *P.S. Short 396*, collected c. 100 km N of the Murchison River Bridge along the North West Coastal Highway. Values ranged from 1,119 to 2,870 ($\bar{x}$ = 1,636; s.d. = 499; s.e. = 129).

*Cytology*. Turner (1970) determined *n* = c. 14 for a population (*B.L. Turner 5372*) collected about 150 miles north of Mullewa.

*Notes*. A somewhat polymorphic species in regard to the shape and degree of hairiness of the capitular bracts and the colour of the terminal lamina. Collections from the Shark Bay region, e.g. *S.D. Hopper 1371* & *A.S. George 11403*, have inner capitular bracts with an obovate claw, compared to the more common widely elliptic to circular or widely to very widely obovate claw found in specimens such as *P.S. Short 587*. Furthermore, in *S.D. Hopper 1371* & *A.S. George 11403* the margins of the claw of the inner capitular bracts lack or have very few hairs. The bulk of the inland specimens have much more hairy margins and there is a general gradation to fewer hairs toward the coast, with differences in the degree of hairiness tending to be associated with change in the shape of the claw. The specimen *A.S. George 11403*, from Dirk Hartog Island, is also an unusual collection in that the terminal lamina of the bracts is white, this being particularly obvious in the elements which comprise the PERTH specimen, and less so on elements of the duplicate specimen at AD where a hint of yellow is evident.

It may be due to age but the globose twin-hairs on the fruit do not appear to be myxogenic. I have soaked fruit which were several years old in water for three days without a mucilaginous layer forming on the surface.

As cited by Bentham (1867a), James Drummond collected this species, his collection being *Drummond 161*. It is represented in E (E 00433317, erroneously as a 'type'), Harvard (GH 00004568, erroneously as a 'type') and MEL (MEL 85059). It also appears that a duplicate is held at Geneva (G 00222879), but it is erroneously labelled as *Calocephalus angianthoides* and attributed to Preiss.

*Selected specimens examined.*

Western Australia: 1 km E of Kalbarri, 26 Sep. 1976, *R.J. Chinnock 3185* (AD); Dirk Hartog Is., 2 Sep. 1972, *A.S. George 11403* (AD, PERTH); 25 km SW of Cooloomia Hmsd, 18 Sep. 1979, *S.D. Hopper 1371* (PERTH); "The Boats", c. 27 km from Laverton along road to Leonora, 20 Aug. 1982, *P.S. Short 1527* (MEL, PERTH); 16 km W of Gascoyne Junction, 20 Aug. 1986, *P.S. Short 2518* (AD, MEL, PERTH).

### 5. *Calocephalus glabratus* P.S.Short, *sp. nov.*

**Type:** Queensland. Currawinya Lakes N.P., eastern side of Hoodis Range, 28°37'S, 144°46'E, grassy swale between mound springs, 4 Apr. 1997, *E. Addicott CL4* (holotype: BRI AQ654298).

*Calocephalus* sp. Eulo (*M.E. Ballingall MEB2590*), Queensland Checklist sensu A.E. Holland (2010), www.anbg.gov.au/cgi-bin/apclist [accessed 7 Mar. 2012].

*Subshrub* or robust herb; major branches somewhat rigid, prostrate to ascending, to c. 40 cm long, glabrous or with a few scattered, long, septate hairs. *Leaves* alternate, sessile, entire, somewhat linear or lanceolate, the upper part sometimes recurved, 4–16 mm long, 0.5–1.3 mm wide, glabrous or with a few scattered long, septate hairs. *Compound heads* globular or obloid, c. 5–10 mm long, 5–15 mm diam.; bracts subtending compound heads numerous, in several rows, the outermost bracts leaf-like but with hyaline margins, the mid to inner bracts with a white lamina, all bracts densely cottony; *general receptacle* branched, densely cottony. *Capitula* to c. 20 per compound head. *Capitular bracts* in 2 rows. *Outer bracts* c. 5, spathulate, 2.9–3.7 mm long, c. 0.8–1.1 mm wide, the lower margins not or narrowly hyaline, upper margins hyaline and developing into a hyaline, sometimes pale white lamina, the midrib extending c. 4/5 the length of the bract, numerous long intertwined hairs at the apex of the midrib. *Inner bracts* c. 4, hyaline, midrib indistinct, extending c. 4/5 the length of the bract, obovate to oblanceolate, 2.4–3.2 mm long, 0.8–1.1 mm wide, glabrous or with long hairs near the apex of the midrib and along the hyaline margins, a terminal lamina not, or barely, differentiated. *Partial receptacle* conical, glabrous. *Florets* 4–7, bisexual. *Corolla* 5-lobed; lobes with thick margins and apparently lacking papillae on inner surface; tube 2–2.4 mm long; inner epidermal cells of lobes and throat with straight walls, the cells not in distinct rows; vascular tissue extending to the base of the lobes. *Style* with 2 distinct vascular traces from the base, nectary present, branches truncate, c. 0.8 mm long, apices papillate. *Stamens* 5; anthers c. 1–1.2 mm long, caudate; microsporangia c. 0.9 mm long; apical appendages subtriangular, c. 0.25 mm long; filament collar more or less straight in outline but dilated towards the base. *Cypselas* c. 1 mm long, c. 0.5 mm diam., brown, glabrous or with scattered, probably myxogenic, twin hairs with basal cells; carpopodium annular. *Pappus* of 7–14, sub-flexuose, white bristles

about the length of the corolla, joined at the base, bristles long-plumose throughout their length, with a terminal tuft. *Chromosome number*: unknown. **Fig. 6.**

*Distribution*. Restricted to the Eulo–Thargomindah area of south-western Queensland.

*Habitat*. Locality notes accompanying *M.E. Ballingall 2590* record that the specimen was collected from along a drainage flat where plants were growing "in reddish-brown loam with stony pavement" amongst "herbland chenopods and other Asteraceae"; for *M. Wilson* (BRI AQ533064) it was noted that plants were growing on the "crest of [the] mound spring on the edge of the mud"; while plants at Basin Bore in Currawinya N.P. (*P.I. Forster* 20461) were very common in "Grassland on claypan with scattered clumps of *Myoporum*".

*Phenology & reproductive biology*. Flowering specimens have been collected from March to September.

A pollen:ovule ratio of 4,952 was obtained from a single floret of *M.E. Ballingall 2590*, collected from Granite Springs Station.

*Etymology*. The specific epithet refers to the stems and leaves being almost devoid of hairs.

*Notes*. This species, presumably because of the well-developed general involucre, has previously been referred to *Myriocephalus appendiculatus* Benth. following a determination by J.H. Willis of *S.T. Blake 11715* (MEL), or as an unnamed species of *Myriocephalus*. However, it is readily distinguished from *Myriocephalus* s.str. by its plumose pappus bristles and fruit morphology, etc.

*Additional specimens examined.*

Queensland: On Granite Springs Stn c. 22 km S of Eulo–Thargomindah road, 4 Sep. 1990, *M.E. Ballingall 2590* (BRI AQ501143, MEL1588568); Eulo, at edge of mud springs, 22 June 1936, *S.T. Blake 11713* (BRI, MEL); Currawinya N.P., Basin Bore, 19 Mar. 1997, *P.I. Forster 20461* (BRI AQ 604061, DNA, MEL n.v., NSW n.v.); Currawinya N.P. on the eastern drainage of Hoods Range, 12 Aug. 2004, *S. Peck lot458* (BRI AQ612511); Currawinya N.P. on the eastern drainage of Hoods Range, 12 Aug. 2004, *S. Peck lot459* (BRI AQ612510); Yowah Ck, SSE of Yowah Mound Spring on track leading to Twelve Mile Waterhole, 20 Mar. 1997, *M. Wilson* (BRI AQ533064).

### 6. *Calocephalus knappii* (F.Muell.) Ewart & Jean White

Proc. Roy. Soc. Victoria 22: 319, pl. 58, figs 1, 2 & 9 (1910); Chippendale, Trans. Roy. Soc. S. Austral. 82: 337 (1959); P.S.Short in Jessop, Fl. Centr. Austral. 392 (1981); P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1502 (1986). — *Eriochlamys knappii* F.Muell., Australas. Chem. Druggist 6: 4 (May 1883). — **Type citation:** "In the vicinity of the Finke River; Rev. H. Kempe." **Lectotype (here designated):** Finke River, 1882, *F.A.H. Kempe 503* (MEL 543276 & MEL 543277, see below). **Isolectotype:** NSW 139002. **Remaining syntypes, isosyntypes & possible isolectotypes:** Finke River, Dec. 1879, *F.A.H. Kempe* (MEL 543280, NSW 139001); Finke River, 1880, *F.A.H. Kempe* (MEL 543279); Finke River, 1882, *F.A.H. Kempe* (MEL 543278); Finke River, 1882, *F.A.H. Kempe 516* (MEL 543281); Finke River, *F.A.H. Kempe* (K 000901837, but perhaps collected July 1883); Finke River, Central Aust., *F.A.H. Kempe* (K 000901838, received at K 4/1888); Finke River, *F.A.H. Kempe* (AD 97632031, ex herb. J.M.Black, fragments only, presumably obtained from MEL).

Annual *herb*; major branches decumbent to erect, 3–30 cm long; stem simple in the smaller plants but usually forming major branches at basal and/or upper nodes, all branches cottony, the long, septate hairs with broad, flat bases, also short, glandular hairs present. *Leaves* alternate, entire, ovate to lanceolate, or elliptic or linear, 5–32 mm long, 2.5–6 mm wide, spreading to adpressed, subglabrous to densely hairy, with long, septate hairs with broad, flat bases, also with scattered, glandular hairs. *Compound heads* broadly ovoid to ovoid or globular or somewhat oblong, 6–16 mm long, 6–11 mm diam.; bracts subtending compound heads more or less absent; *general receptacle* branched, cottony, each secondary peduncle terminating in c. 3–5 capitula. *Capitula* 20–70 per compound head, each one usually subtended by a bract which resembles the outer capitular bracts. *Capitular bracts* in two rows. *Outer bracts* 6–9, narrowly oblanceolate, 2–3.5 mm long, 0.2–0.7 mm wide, predominantly (rarely entirely) green, but with a hyaline apex and sometimes narrow hyaline margins, always with long hairs extending from the margins. *Inner bracts* 7 or 8, lanceolate, 1.8–3.2 mm long, 0.4–1 mm wide, entirely hyaline or sometimes with a very small opaque base, usually with long hairs extending from the margins. *Partial receptacle* somewhat conical, with minute but distinct pedicels, glabrous. *Florets* 10–18, bisexual. *Corolla* campanulate, 5-lobed; lobes with thick margins, inner surface variably papillate (?sometimes absent) at the base; tube 1.6–2.4 mm long; inner epidermal cells of lobes with more or less straight walls, those of the tube undulate, cells not in distinct rows; vascular tissue not extending to the base of the lobes. *Style* with 2 distinct vascular traces from the base, nectary small, branches truncate, c. 0.6–0.7 mm long, apices papillate. *Stamens* 5; anthers c. 0.71–0.92 mm long, caudate; microsporangia 0.53–0.72 mm long; apical appendages triangular, c. 0.17–0.23 mm long; filament collar mostly more or less straight in outline but dilated towards the base. *Cypselas* obovoid, 0.45–0.5 mm long, c. 0.3 mm diam., brown, seemingly glabrous but the epidermis with inconspicuous, globose twin-celled papillae; pericarp with a layer of sclerenchyma (*D.W. Goodall 3440*); vascular bundles in pericarp 2, lateral; carpopodium absent, the abscission area not differentiated from the pedicel. *Pappus* of 3–6 lax, plumose bristles c. as long as the corolla tube, also some smaller bristles often present, all bristles scarcely united at the base. *Chromosome number*: $n = 14$. **Fig. 1C.**

*Distribution*. Widespread, occurring in south-western Queensland, central Australia and much of Western Aus-

tralia but avoiding the sandy deserts, i.e. Great Sandy, Gibson and Simpson Deserts.

*Habitat*. It grows in a number of different arid zone plant communities. Collectors' notes include: "In ... red sand with *Triodia*", "Reddish sandy loam, *Acacia* dominant", "*Acacia* over spinifex", "Sandy loam with surface gravel. Mulga scrub.", "Open ground of mulga flat. Red loam with buckshot gravel, small quartz & ironstone pebbles on surface", "Red loam over limestone" and "Open floodplain; compact sandy loam".

*Phenology & reproductive biology*. Most flowering specimens of *C. knappii* have been collected from about late July to mid-October but specimens have been collected in all months except January, April and December.

Pollen:ovule ratios determined for five florets from *P.S. Short 4306* , collected at the Yannarie River crossing along the North West Coastal Highway, W.A., ranged from 2,036 to 2,872 ($\bar{x}$ = 2,351; s.d. = 321; s.e. = 161).

*Cytology*. Watanabe et al. (1999) recorded $n = 14$ from a population (*P.S. Short 4413*) at a crossing of Beasley Creek along the road linking Laverton and Bandya, W.A.

*Lectotypification*. The lectotype specimen, *F.A.H. Kempe 503*, which is designated here was collected in 1882 and, as was regular practice at that time in MEL, the elements of which it is composed would have been unmounted and retained in a single folder. In later years when it was mounted the individual elements were distributed over two sheets. Each sheet was stamped with a different accession number but the fact that they formed part of the same collection was recorded, the sheet numbered MEL 543276 labelled as being "Sheet 1 of 2", while MEL 543277 was labelled as "Sheet 2 of 2". Both sheets are therefore regarded as constituting a single specimen, which is in accord with Article 8.3, Ex. 4 of the *Code* (McNeill et al. 2012).

*Notes*. Readily distinguished from other species by the viscous nature of the florets, an absence of distinct coloured terminal laminae in the inner capitular bracts, and the usually long-ciliate margins of the capitular bracts.

*Selected specimens examined.*

Western Australia: 38 miles S of Neale Junction, 12 Oct. 1966, *A.S. George 8459* (KPBG, PERTH); 1.4 km from Towera Hmsd turnoff on Towera–Lyndon Hmsd road, 25 Aug. 1977, *P.S. Short 479* (AD); c. 8 km S of Sullivan Ck on Leonora–Agnew road, 10 Oct. 1983, *P.S. Short 2012* (AD, MEL, PERTH).

Northern Territory: 15 miles SW of White Quartz Hill Hmsd, 14 Aug. 1959, *G.M. Chippendale* (AD 9675003, BRI, NT 6527–to DNA, NSW); 6 km E of Jessie Gap, 10 Aug. 1988, *P.S. Short 3143* (MEL); 26 miles NW of Haasts Bluff, 7 Sep. 1956, *R.E. Winkworth 1419* (CANB, NT).

South Australia: Mt Harriet road, 45 km S of Musgrave Park Stn, 28 Oct. 1966, *J.Z. Weber 138* (AD).

Queensland: 23 miles N of Thargomindah, 28 Sep. 1968, *L.D. Williams 114* (BRI).

**7. *Calocephalus multiflorus* (Turcz.) Benth.**

Fl. Austral. 3: 576 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 822 (1975). — *Pachysurus multiflorus* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24 (1): 192 (27 March 1851), basionym. — *Leucophyta multiflora* (Turcz.) Kuntze, Revis. Gen. Pl. 1: 352 (1891). — **Type citation:** "Nova Hollandia. *Drum. coll. III. n. 117.*" **Syntypes:** *J. Drummond 3:117* (KW 001001489, see note below; MEL 543201, ex herb Steetz, annotated by Turcz.; P 00715997, ex herb. Schultz-Bip., annotated by Turcz.). **Isosyntypes:** E; GH 00010847, ex herb. Klatt; K 000901842, ex herb. Benth 1854; K 000901840 p.p. (see notes); MEL 543202; NSW; P 00715996, ex BM, received 1914; PERTH, ex K, ex TCD, 2 sheets; PERTH (ex MEL). **Possible isosyntypes:** *J. Drummond* (MEL 85125).

*Achrysum glomeratum* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 4: 229 (Aug. 1852). — **Type citation:** "Swan River, *Drummond.*" **Syntypes & isosyntypes:** *J. Drummond 3: 117* (E; K 000901842, ex herb. Benth. 1854; K 000901840 p.p., ex herb. Hook. 1867; GH 00010847, ex herb. Klatt; KW 001001489, see notes below; MEL 543201, ex herb. Steetz; MEL 543202, number '18' crossed out; NSW; P 00715996, ex BM, received 1914; P 00715997, ex herb. Schultz-Bip.; PERTH, ex K, ex TCD, 2 sheets; PERTH, ex MEL); *J. Drummond 5*: *389* (G 00222877; K 000901841, ex herb. Benth 1854; K 000901840, p.p., ex herb. Hook. 1867; PERTH, ex K, ex TCD; KW 001001488; KW 001001490, see note below). **Possible isosyntypes:** *J. Drummond* (MEL 85125). *J. Drummond 5: 388* (P 03312998, ex BM, received Apr. 1923).

Annual *herb*, stem and major branches 5–16 cm long, ascending to erect, with a sparse to dense cottony indumentum, the long, septate hairs with broad, flat bases. *Leaves* alternate, sessile, entire, narrowly elliptic, lanceolate, or oblanceolate, 4–23 mm long, 0.6–5.5 mm wide, cottony, with the long, septate hairs with broad, flat bases, also with scattered, yellow, glandular hairs, leaves sweetly aromatic, most leaves slightly mucronate, the uppermost usually with a small hyaline tip. *Compound heads* very broadly to depressed ovoid, c. 4–18 mm long, 5–18 mm diam.; bracts subtending compound heads absent but each of the lower capitula subtended by a single, mainly foliaceous bract; *general receptacle* branched, sparsely cottony, each secondary peduncle terminating in 2–10 capitula. *Capitula* c. 10–180 per compound head, each one usually subtended by a bract, the lower capitulum-subtending bracts mainly foliaceous, the upper hyaline except for a midrib extending for most of the length, often densely hairy. *Capitular bracts* in 2 rows. *Outer bracts* c. 6, usually hyaline except for a midrib extending for c. the length of the claw or sometimes the midrib with only narrow hyaline margins, all bracts united by long intertwined hairs which often invest much of the midrib; claw somewhat elliptic, 1.2–1.5 mm long, 0.7–0.9 mm wide, upper margins with long hairs; terminal lamina widely depressed to depressed ovate, 0.3–0.35 mm long, 0.4–0.5 mm wide, more or less distinguished by a constriction above the midrib, pale yellow. *Inner bracts* 7 or 8, entirely hyaline or sometimes with an indistinct

midrib extending to c. ⅓ the length of the claw, all bracts united by long, dense, intertwined hairs at the base of the terminal lamina; claw elliptic or obovate, 1.4–1.8 mm long, 0.5–1.1 mm wide, upper margins with long hairs; terminal lamina circular or transversely elliptic, 0.2–0.4 mm long, 0.3–0.6 mm wide, somewhat concave, usually reflexed, yellow. *Receptacle* more or less conical, glabrous. *Florets* 8–16, bisexual. *Corolla* 5-lobed; lobes with slightly thickened margins, lacking papillae on inner surface or slightly papillate on some lobes; tube 0.8–1 mm long; inner epidermal cells of lobes and throat with more or less straight walls, the cells not in distinct rows; vascular tissue not, or barely, extending to the base of the lobes. *Stamens* 5; anthers c. 0.6–0.8 mm long, caudate; microsporangia 0.45–0.63 mm long; apical appendages narrowly triangular, c. 0.15–0.2 mm long; filament collar more or less gradually dilating towards the base. *Style* with 2 distinct vascular traces from the base, nectary ?absent or barely developed, branches truncate, 0.27–0.32 mm long, apices papillate. *Cypselas* obovoid, c. 0.4 mm long, 0.25 mm diam., brown, glabrous, enveloped by myxogenic hairs; pericarp lacking sclerenchyma (*P.S. Short 2189*); vascular bundles in pericarp 2; carpopodium annular. *Pappus* of 5 or 6 bristles about the length of the corolla, united at the base, bristles irregularly long-plumose in their upper ½ or throughout their length. *Chromosome number*: unknown. **Fig. 1D.**

*Distribution*. Restricted to Western Australia between latitudes 23ºS and c. 32º S and west of c. 123º E.

*Habitat*. This species is common in arid shrubland communities but has also been collected from more temperate regions. The few collectors' notes include: "Open *Acacia–Cassia* [*Senna*] scrub. Sandy loam covered with ironstone gravel", "*Acacia*, mallee *Eucalyptus* scrub. Sand or very sandy loam", "Open woodland of *Melaleuca* & *Acacia* with *Triodia*. Light brown sandy loam soil", "with *Casuarina* & *Hakea* in roadside gravel pit" and "Sand with ironstone gravel. *Acacia*, *Eremophila* shrubland".

*Phenology & reproductive biology*. Flowering specimens have been collected from late August to early November, with those collected in late October and November often with mature or near-mature fruit.

Pollen:ovule ratios ranging from 1,954 to 2,620 ($\bar{x}$ = 2139; s.d. = 267; s.e. = 134) were determined for five capitula from *P.S. Short 4331*, collected c. 11 km south of Boologooro Homestead.

*Typification*. Turczaninow's herbarium in KW contains two sheets of this species. One sheet, KW 001001490, consists of a single element of *J. Drummond 389*, while the other sheet contains a number of elements attributed to both *J. Drummond 117* and *J. Drummond 389*, elements purported to be of *J. Drummond 117* having the herbarium number KW 001001489, those purported to be of *389* having the number KW 001001488. As Turczaninow made no mention of it in his publication, the specimens of *J. Drummond 389* have no type status in regard to the name *Pachysurus multiflorus*, and with Turczaninow's personal herbarium in KW it would normally be considered to house the holotype specimen, i.e. those elements of *J. Drummond 117* which comprise the specimen now labelled as KW 001001489. However, unless a piece of paper appearing to be part of an original label and attached to an element in the right hand bottom corner of the sheet is numbered on the reverse, there is nothing to indicate which of the attached 14 elements actually belong to Drummond's numbers *117* and *389*. Thus, I have merely indicated that KW houses a syntype specimen. The two further syntypes, i.e. MEL 543201 and P 00715997 (ex herb. Schultz-Bip.), both contain labels in Turczaninow's hand and, as noted in Short & Sinkora (1988), the former specimen was probably obtained by Joachim Steetz in 1852. There is no evidence on the sheets, or in publication, that Turczaninow saw additional specimens of *Drummond 117* in K, MEL, P and PERTH and these are accordingly regarded as isosyntypes.

Gray did not refer to a numbered Drummond specimen in the protologue pertaining to the name *Achrysum glomeratum* but at K there is a single sheet (K 000901840, stamped Herbarium Hookerianum 1867) on which is pencilled "*Achrysum glomeratum*, n. gen" in what I believe to be Gray's hand. Numerous individuals are attached to the sheet and — as with specimens in KW — it consists of elements purported to be of *J. Drummond 117* and *J. Drummond 389* but with no clear indication as to which elements belong to the respective numbers. There are also *J. Drummond 389* specimens in both G and PERTH. With the exception of K 000901840 no other possible syntype or isosyntype specimens of *Achrysum glomeratum* listed above are annotated by Gray.

A specimen at P (P 03312998) labelled as *J. Drummond 388* and coming from the fifth collection is not annotated by Gray and does not contain an original Drummond label. I listed it above as a possible isosyntype of the name *Achrysum glomeratum* on the assumption that it should be labelled as *J. Drummond 389*.

*Selected specimens examined.*

Western Australia: 12 km SW of Paynes Find, 13 Nov. 1983, *L. Haegi 2656* (AD, MEL, PERTH); Merredin, 6 Nov. 1923, *M. Koch 2937* (NSW); Pindar, Oct. 1909, *J.H. Maiden* (CANB 246317, NSW 128037); 36 km from Laverton along road to Bandya Stn, 21 Aug. 1982, *P.S. Short 1532* (MEL); 20 km S of Boologooro Hmsd, 13 Oct. 1983, *P.S. Short 2051* (AD, CANB, MEL, PERTH).

### 8. *Calocephalus pilbarensis* P.S. Short, *sp. nov.*

**Type:** Western Australia. c. 2 km S. of Fortescue River crossing along Marble Bar road, 22º 34' 28" S, 119º 57' 18"E, in open *Eucalyptus* woodland on floodplain, 28 Aug. 1995, *P.S. Short 4261* (holotype: MEL 2027673; isotypes: AD, BRI, CANB, K, NSW, PERTH, S).

*Calocephalus* sp. Wittenoom (*A.S. George 1082*) WA Herbarium, as per both florabase.dec.wa.gov.au/search/current/16525 and www.anbg.gov.au/cgi-bin/apclist [both accessed 7 Mar. 2012].

Annual *herb*; major branches axes ascending to erect, to c. 45 cm long, with a sparse to dense cottony indumentum, stalked glandular hairs often present, when devoid of cottony hairs the axes yellowish, greyish when densely cottony. *Leaves* alternate, basal and cauline, descending in size towards the compound heads, mostly lanceolate to linear-lanceolate or somewhat linear-oblanceolate, 10–60 mm long, 0.1–0.8 mm wide, apically with a blunt mucron, dark green to grey due to sparse to dense indumentum of cottony, white, eglandular hairs as on stems. *Compound heads* spheroid to broadly ellipsoid or very broadly ovoid, 9–15 mm long, 11–18 mm diam.; general involucre absent but scattered, leaf-like, somewhat linear or oblanceolate and sparsely to densely cottony bracts visible at and about the base of immature compound heads and amongst the capitula, such bracts inconspicuous in mature compound heads; general receptacle short, somewhat oblong, unbranched and the capitula sessile. *Leaf-like, capitulum-subtending bracts* linear or narrowly oblanceolate as per those around the base of the compound head. *Capitula* c. 35–45 per compound head (37 capitula from single compound head 14 mm long, 15 mm diam.). *Capitular bracts* c. 16–21 in about 3 rows, all bracts with a distinct claw and terminal lamina, mostly hyaline except for a pale yellow-green midrib extending c. the length of the claw, the terminal lamina well-formed, c. 1.4–1.9 mm long, 1.2–1.9 mm wide, concave, distinctly delimited and the inner ones reflexed to c. 90° but as with the hyaline margins almost colourless and therefore inconspicuous; *outermost bracts* c. 5 or 6, differing from the mid-and inner bracts by being shorter, having narrower midribs, and in being somewhat woolly, having longer and more numerous intertwined hairs which extend from c. the upper ½ of both the midrib and hyaline margins of the claw; *mid- and innermost bracts* c. 3.8–5.5 mm long, 1.2–1.9 mm wide; bracts in both rows united by long, white, intertwined hairs extending from the apex of the midrib and the hyaline margins at the claw/lamina interface. *Florets* 8–12, bisexual. *Corolla* 5-lobed; lobes with their inner surfaces minutely papillate throughout; tube 2.6–3.1 mm long; inner epidermal cells of throat mostly with straight walls but some cells with somewhat undulating margins; vascular tissue extending to c. ¼ the length of the lobe. *Style* with 2 distinct vascular traces from the base, nectary small (c. 0.15 mm long), branches truncate, c. 0.7–0.75 mm long, apices long-papillate. *Stamens* 5; anthers 1.45–1.52 mm long, microsporangia 1.1–1.18 mm long, shortly caudate, each with a subtriangular terminal appendage 0.3–0.37 mm long, the appendage with a definite central thickening extending its length; filament collar almost straight in outline, only slightly and gradually expanding to the base. *Cypselas* somewhat compressed obovoid, 1.2–2 mm long, 0.45–1 mm wide, densely sericeous, except at the base the white, straight, appressed, eglandular hairs obscuring the surface of the fruit, the upper hairs exceeding the fruit body by c. 0.3–0.7 mm; carpopodium appears to be absent. *Pappus* of 9–13 weakish, white bristles c. the length of the corolla tube, joined at the base, bristles subplumose at the base but the hairs grading to very long plumose and becoming tangled towards the apex. *Chromosome number*: unknown. **Fig. 7.**

*Distribution*. Common in north-west W.A., including the Pilbara, with most records between c. 22º and 25º S, and west of 121º E.

I believe the specimen *W.D. Campbell* (PERTH), collected in 1902, is probably erroneously labelled as being collected from Cue, a locality which would represent a fairly major disjunction from its otherwise known distribution. As Cue lies on the Great Northern Highway I would also have expected it to have been collected from that region on other occasions.

*Habitat*. A species of very open eucalypt woodland, *Acacia* shrubland, and tussock-grass plains, it grows in red loam or clay-loam soil. In good seasons it is prolific and a dominant component of the landscape (e.g. see florabase.dec.wa.gov.au/browse/photo/16525).

*Phenology & reproductive biology*. Mostly collected in August but, assuming specimens referred to as *Calocephalus* sp. Wittenoom (*A.S. George 1082*) are correctly identified, data seen at both the Australian Virtual Herbarium and the Florabase websites [accessed 20 June 2015] indicate that they have been gathered from May to October.

All florets, by virtue of having separating style arms and developed stigmatic surfaces, and each with at least an immature ovary, appear to be bisexual but it was noticeable in 11 capitula sampled from *P.S. Short 4261* that there was always a substantial number of florets in which cypselas never developed, the ratio of florets with developed:undeveloped cypselas being 3:5, 4:7, 4:7, 4:7, 4:8, 4:8, 5:6, 5:6, 5:7, 5:7 and 6:5. Low fruit set was also evident in other specimens.

On the assumption that all florets are bisexual a pollen:ovule ratio of 7,790 pollen grains was determined from a single floret of the type specimen, *P.S. Short 4261*. It is a very high value compared to many other members of the Australian Gnaphalieae for which I have recorded pollen:ovule ratios, one that not only suggests that cross-pollination is common but also suggests self-incompatibility; the latter suggestion would explain the low fruit set, albeit that environmental factors — particularly a lack of rain — may curtail fruit development.

*Etymology*. In reference to the distribution of the species in and around the Pilbara region.

*Notes*. I have referred in the above description to small leaf-like, capitulum-subtending bracts within the compound heads. However, without destroying numerous compound heads I could not determine their

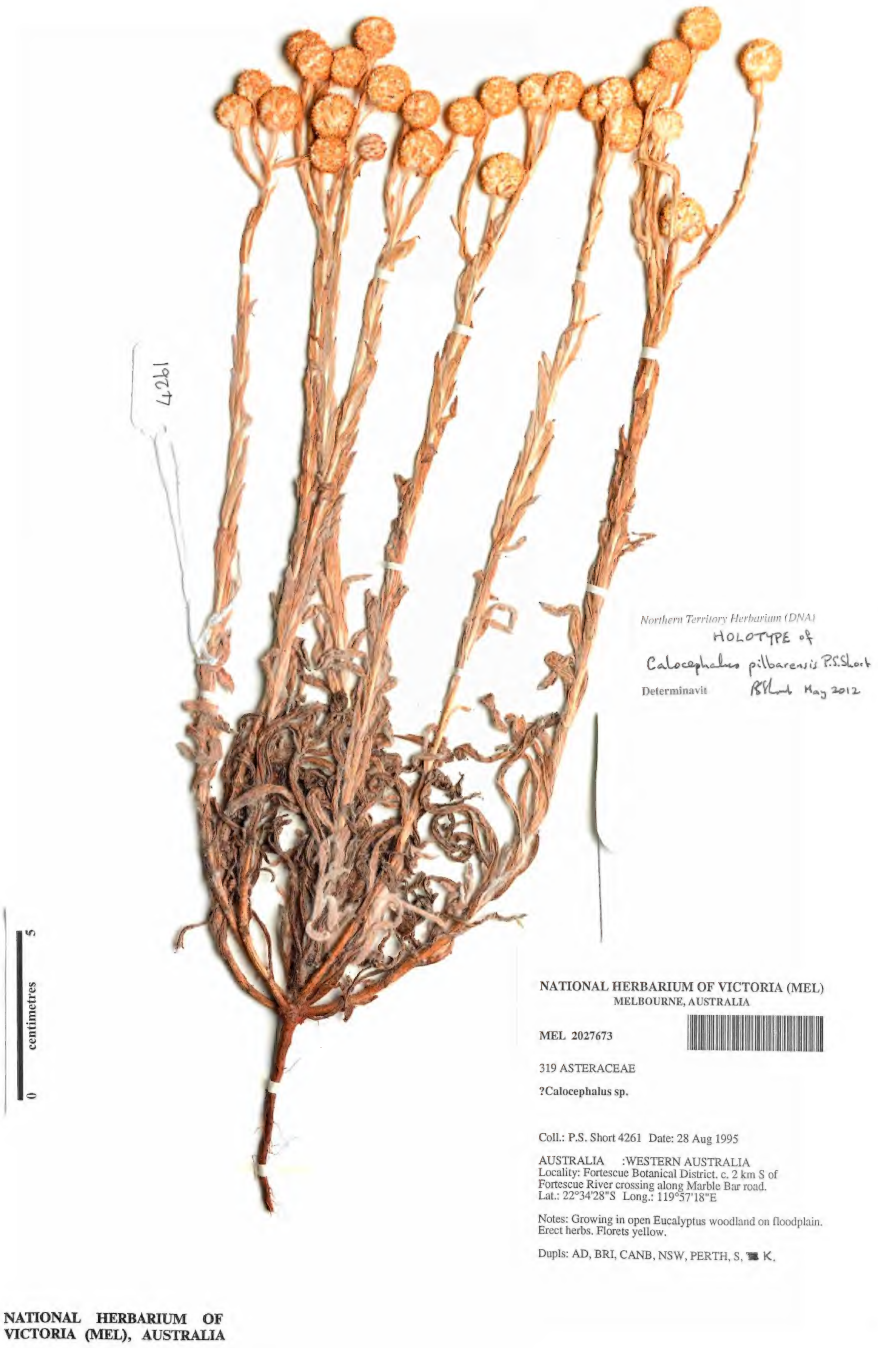


**Fig. 7.** Holotype of ***Calocephalus pilbarensis*** (MEL), — *P.S. Short 4261.*

arrangement with certainty nor establish that one (or perhaps more) even consistently subtends every capitulum.

This species is clearly differentiated from all other species included within *Calocephalus* s.lat. by its sericeous cypselas.

At least superficially this species appears to be related to *Pycnosorus* Benth., revised by Everett & Doust (1992), both taxa having compound heads, sessile capitula, well-developed plumose pappus bristles and sericeous cypselas. It differs from *Pycnosorus* in its lack of receptacular bracts and in having white, not yellow, pappus bristles and almost colourless, not yellow, capitular bracts.

*Selected specimens examined.*

Western Australia: Balfour Downs, 8 Aug. 1966, *J.S. Beard 4472* (KPBG, PERTH); Hamersley Stn, 28 Aug. 1970, *J.S. Beard 6132* (KPBG n.v., NSW, PERTH); about 15 km SW of Balfour Downs Hmsd on track to Jigalong, 31 Aug. 1995, *A.A. Mitchell PRP540* (MEL, PERTH n.v.); 45 km from Tom Price along Marandoo Development road, 30 Aug. 1995, P.S. Short 4282 (AD, MEL, NSW, PERTH); Mt Augustus Stn, 23 Aug. 1973, *E. Wittwer 1118* (PERTH).

### 9. *Calocephalus platycephalus* (F.Muell.) Benth.

Fl. Austral. 3: 576 (1867); C.Moore & Betche, Handb. Fl. New South Wales 289 (1893); F.M.Bailey, Queensl. Fl. 851 (1900); Maiden & Betche, Census N.S.W. Pl. 200 (1916); Chippendale, Trans. Roy. Soc. South Australia 82: 337 (1959); P.S.Short in Jessop, Fl. Centr. Austral. 392 (1981); G.M.Cunningham et al., Pl. W. New South Wales 706 (1981); P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1504 (1986); E.A.Brown in G.J.Harden, Fl. New South Wales 3: 259 (1992). — *Pachysurus platycephalus* F.Muell., Fragm. 3: 154 (1863). — *Leucophyta platycephala* (F.Muell.) Kuntze, Revis. Gen. Pl. 352 (1891). — **Type citation:** "Ad flumen Darling; Goodwin. Ad montes Barrier Range; Beckler. Ad sinum Spencer's Gulf; Warburton." **Lectotype (here designated):** Darling River, [1858/59], [*J.*] *Dallachy* & [*T.H.*] *Goodwin* (MEL 543210). **Isolectotypes:** K 000901843, MEL 543211, MEL 543213. **Remaining syntypes or possibly isolectotypes:** Darling River, [1858/59], [*J.*] *Dallachy* (MEL 543212, NSW 139017); Lake Menindee, River Darling, Nov. 1858, [*J.*] *Dallachy* (MEL 85145). **Remaining syntypes:** Towards Spencers Gulf, *Warburton* (MEL 85146); Vict. Exped. 12 March 1861, [*H.*] *Beckler* (MEL 543209 p.p.); Darling River to Barrier Range, Victoria Expedition (K 000901844); Near Cariapundi [Caryapundy], 19 March [1861], [*H.*] *Beckler* (MEL 543209 p.p.).

*Calocephalus dittrichii* F.Muell., S. Sci. Rec. Mag. Nat. Hist. 2 (May 1886) & Bot. Centralbl. 27: 300 (1886, post May); C.Moore & Betche, Handb. Fl. New South Wales 289 (1893); F.M.Bailey, Queensl. Fl. 851 (1900); Stapf, Index Lond. 531 (1929), as "*dietrichii*". — *Myriocephalus dittrichii* F.Muell., S. Sci. Rec. Mag. Nat. Hist. 2 (May 1886) & Bot. Centralbl. 27: 300 (1886, post May), nom. inval., pro syn. — *Leucophyta dittrichii* (F.Muell.) Kuntze, Revis. Gen. Pl. 352 (1891). — **Type citation:** "Near Charlotte-Waters; Lieutenant Dittrich; collected during Mr. Lindsay's Expedition." **Lectotype (here designated):** South of Charlotte Waters, 1885, *Lieut. Dittrich 37* (MEL 543272).

[*Calocephalus multiflorus* auct. non (Turcz.) Benth.: J.M.Black, Fl. S. Austral. 1st ed. 648 (1926), 2nd ed. 928 (1957); H.Eichl., Suppl. J.M.Black's Fl. S. Austral. 327 (1965); R.J.Henderson (ed.), Names & Distrib. Queensl. Pl., Algae & Lichens 26 (2002); P.D.Bostock & A.E.Holland (eds), Census Qld Fl. 24 (2007); P.D.Bostock & A.E.Holland (eds), Census Qld Fl. 19 (2010).]

Annual, or perhaps sometimes longer-lived *herb*, with ascending to erect branches 8–50 cm long, branches with a sparse to dense cottony indumentum. *Leaves* alternate, sessile, entire, linear or lanceolate, 5–30 mm long, 1–5.5 mm wide, with a sparse to dense cottony indumentum, the uppermost usually with a small hyaline tip. *Compound heads* broadly depressed to depressed ovoid or globular, 6–20 mm long, 8–30 mm diam., tertiary "heads" present in the larger inflorescences; bracts subtending compound heads numerous, in several ill-defined rows, mainly hyaline, somewhat similar to the outer capitular bracts but with the midrib more prominent and the entire outer surface of the midrib cottony. *General receptacle* branched, cottony. *Capitula* 10–160 per compound head. *Capitular bracts* c. 17–22 in about 2 rows. *Outer bracts* hyaline except for a midrib extending c. the length of the claw, bracts more or less glabrous or united by long intertwined hairs at the apex of the midrib, their hyaline margins being entire; claw oblanceolate to obovate, 2.2–3 mm long, 0.6–1.3 mm wide; terminal lamina very widely ovate, 0.5–1.1 mm long, 0.6–0.9 mm wide, often distinguished from the claw by a constriction above the midrib, yellow. *Inner bracts* hyaline except for a midrib extending c. the length of the claw, glabrous; claw elliptic or obovate, 2.7–3.1 mm long, 0.9–1.3 mm wide; terminal lamina very widely ovate to depressed ovate, 0.3–0.7 mm long, 0.5–0.7 mm wide, pale yellow. *Partial receptacle* conical, glabrous. *Florets* 12–22, bisexual. *Corolla* 5-lobed; lobes with thick margins and lacking papillae on inner surface; tube 1.8–2.5 mm long; inner epidermal cells of lobes and throat with straight walls, the cells not in distinct rows; vascular tissue extending to the base of the lobes. *Style* with 2 distinct vascular traces from the base, nectary ?absent or barely developed, branches truncate, c. 0.5–0.6 mm long, apices papillate. *Stamens* 5; anthers c. 0.85–1 mm long, caudate; microsporangia c. 0.71–0.76 mm long; apical appendages subtriangular, c. 0.14–0.2 mm long; filament collar c. 0.3 mm long, more or less straight in outline but slightly dilating towards the base. *Cypselas* obovoid, 0.5–0.62 mm long, 0.25–0.3 mm diam., brown, with globose (?myxogenic) twin-hairs which seemingly have basal cells; vascular bundles in pericarp 2; carpopodium annular. *Pappus* of 6–11 flexuose, bristles c. the length of the corolla tube, joined at the base, bristles plumose throughout their length, often with yellowish terminal tufts. *Chromosome number*: $n = 12$. **Fig. 1E.**

*Distribution*. Common in central Australia (W.A., N.T., S.A., Qld, N.S.W.), but barely extending into W.A. where it only occurs in the Central Ranges biogeographical

region. If correctly labelled, a specimen from Springvale, near Jericho, Qld (*V. Scarth-Johnson 51*) represents a major disjunction in the distribution of the species.

*Habitat*. *Calocephalus platycephalus* grows in an array of arid-zone habitats, including *Acacia* shrubland on low sand dunes, *Eucalyptus terminalis* open woodland with shrub story dominated by *Senna* spp., with *Triodia pungens* on the margins of salt lakes, on *Atriplex nummularia* flats, and seasonally inundated floodplains with cracking clay.

*Cytology*. Watanabe et al. (1999) recorded $n = 12$ for a population (*K. Watanabe 670*) in the vicinity of Alice Springs.

*Phenology & reproductive biology*. The majority of specimens have been collected from about August to October but flowering specimens have been collected in all months.

A pollen:ovule ratio of 2,324 was determined from a single floret of *P.S. Short 3140* which was collected from near Palm Valley in the Finke River Gorge, N.T.

*Lectotypification of Pachysurus platycephalus*. The Rev. Goodwin assisted the curator of the Melbourne Botanic Gardens, John Dallachy, during the latter's collecting trip in the Darling River–Mt Murchison region of New South Wales in 1858–1859 (Mueller in unpublished monthly reports to the Chief Secretary, housed at MEL). Thus, although Goodwin's name is missing from the labels of MEL 543212, MEL 85145 and NSW 139017, it is possible that these collections are duplicates of the lectotype.

The sheet MEL 543209 contains several branches and an envelope of fragments of this taxon. The material looks as if it may be from the one gathering, but there are four labels indicating that it consists of at least two collections. One label is seemingly in Mueller's hand and is in general accord with the protologue, i.e. "North Barrier Ranges, Dr Beckler", indicating that the sheet contains syntype specimens. Other label data, cited above, indicate that specimens were actually gathered on the 12th and the 19th March 1861, with the latter gathered near Caryapundy.

Bentham (1867a) referred to a specimen "Towards Spencer's Gulf (a fragment only), *F. Mueller*" and from the label annotation there is no doubt that this is the specimen MEL 85146. I believe this same specimen is actually that cited by Mueller as "Ad sinum Spencer's Gulf; Warburton" and it is therefore a syntype of *Pachysurus platycephalus* F.Muell.

*Lectotypification and publication of the name Calocephalus dittrichii*. Dittrich, as well as collecting the lectotype specimen of *Calocephalus dittrichii* from "near" or "south" of Charlotte Waters, also gathered this taxon from Stevensons Creek (MEL 84475, PERTH) and Finke River (MEL 84474) when on Lindsay's Expedition in 1885/6. I doubt that either of the last two specimens should be considered to be syntypes of the name *C. dittrichii* as the protologue suggests to me that Mueller was referring only to the one collection, that from Charlotte Waters. The lectotype specimen here chosen is also the only collection annotated as *C. dittrichii* by Mueller. It consists of two plants, both less than c. 15 cm tall, plus some fragments in a separate envelope; the size of these plants is also consistent with the original description in which it was recorded that "the specimens seen about hand-high".

It is believed that volume two of the new series of *The Southern Science Record and Magazine of Natural History* was never issued, although page proofs containing the description of at least some species are believed to have been distributed by Mueller (Chapman 1991, George 2009). I have no record of having seen any copy of a page proof from that journal which refers to the name *Calocephalus dittrichii*. However, that there was a distributed, printed article appears indisputable. In what I take to be a direct copy from the distributed article — the description is enclosed in square brackets — published in *Botanisches Centralblatt* there is reference to the description as being from "Definitions of some new Australian Plants. (From Wing's Southern Science Record. Vol. II. New Ser. May, 1886)"; a lack of cited pagination perhaps supports the belief that they were referring to what Chapman (1991) and George (2009) referred to as "page proofs". The question, in my mind, is whether the distributed material should be regarded as a "page proof", something of questionable validity in regard to publication, or as a "preprint"; the fact that there is direct reference to *The Southern Science Record and Magazine of Natural History* in *Botanisches Centralblatt* suggests the description was considered as a preprint at the time of distribution and that the date of valid publication of the name should be considered to be May 1886. This conclusion is at variance to that presented in APNI (www.cpbr.gov.au/cgi-bin/apni, accessed March 2012) in which it is stated that the name was validly published in *Botanisches Centralblatt*. However, the question is academic, there being no question as to priority of the name in relation to *C. platycephalus*.

That the name *C. dittrichii* is synonymous with the earlier name *C. platycephalus* appears to have been first noted by J.H. Willis in an annotation accompanying the specimen *R.E. Winkworth* (DNA-A19063): "I fail to perceive any difference (except that of age) between TYPE C. dittrichii (near Charlotte Waters) and TYPE C. platycephalus (F.Muell.) Benth. from Darling R. etc. The latter name should stand and I apply it to this collection. J.H. Willis 27/4/1956 Nat. Herb. Victoria".

As evident in his letter dated 26 Apr. 1968 (accompanying *D.J.E. Whibley 1186*, AD) and sent to Judy Wheeler (at AD) it is also apparent that Jim Willis was instrumental in having the name *C. platycephalus* reinstated after it was reduced by J.M. Black (1929) to synonymy under *C. multiflorus* (Turcz.) Benth. Jim had access to type specimens of both taxa at MEL; as

he noted, "Black could not have critically examined the types, or he would surely never have chosen to lump these species".

*Notes*. Distinguished from *C. badmanii* by its habit, the latter being a subshrub with somewhat rigid branches, and in having 6–11 pappus bristles per floret compared with 11–16 in *C. badmanii*. The long-plumose teeth of the pappus bristles also tend to be more spreading in *C. badmanii* than *C. platycephalus*.

*Selected specimens examined.*

Western Australia: Rebecca Ck, 24 Oct. 1989, *B.J. Conn 3460* (MEL, NSW); Warburton Plains, 18 Nov. 1978, *H. Demarz 7220* (CANB, KPBG, PERTH); Lake Hopkins, 5 Oct. 1966, *A.S. George 8337* (PERTH).

Northern Territory: 13 miles S of White Quartz Hill Hmsd, 14 Aug. 1959, *G.M. Chippendale* (AD 96750114, BRI 105067, CANB 214565, DNA ex NT 6525, MEL 85137, NSW, PERTH); 79 miles N of Andado Hmsd, 7 Sep. 1959, *G.M. Chippendale* (AD 96750120, BRI 105059, CANB 214553, DNA ex NT 6574, MEL 85136, NSW, PERTH); Irving Ck, 10 March 1964, *D.J. Nelson 940* (AD, CANB, DNA ex NT, MEL, PERTH).

South Australia: c. 20 km NNW of Quinyambie Hmsd, 31 July 1971, *N.S. Donner 3626* (AD); Level Post Bay, Lake Eyre, 9 Oct. 1980, *B. Lay 1218* (AD, MEL); c. 30 km W of Everard Park Hmsd, 16 Sep. 1963, *D.J.E. Whibley 1186* (AD, MEL).

Queensland: 39 km W of Coorabulka, 10 Sep. 1978, *R. Purdie 1345* (BRI); 5 km S of Glengyle Stn, 24 Aug. 1973, *G.W. Trapnell & K.A. Williams 200* (BRI).

New South Wales: Olive Downs, Dec. 1887, *W.H. Baeuerlen* (BRI 224103); Darling River, *J. Dallachy* (NSW 139017).

### 10. *Calocephalus sonderi* F.Muell.

Rep. Pl. Babbage's Expedition 13 (1859), nom. nov.; F.Muell., Second Gen. Rep. Veg. Colony [Victoria] 12 (1854), nom. nud.; Benth., Fl. Austral. 3: 575 (1867); J.M.Black, Fl. S. Austral. 1st ed. 648 (1929), 2nd ed. 928 (1957); J.H.Willis, Handb. Pl. Victoria 2: 732 (1973); G.M.Cunningham et al., Pl. W. New South Wales 706 (1981); Jacobs & Pickard, Pl. N.S.W. 73 (1981); P.S. Short in Jessop & Toelken, Fl. S. Austral. 3: 1504 (1986); Stanley in Stanley & E.M.Ross, Fl. S.E. Queensl. 2: 546 (1986); E.A.Brown in G.J.Harden, Fl. New South Wales 3: 259 (1992); P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 811, fig. 162f (1999). — *Leucophyta citrea* Sond., Linnaea 25: 490 (1853), non *Calocephalus citreus* Less. (1832). — *Leucophyta sonderi* (F.Muell.) Kuntze, Revis. Gen. Pl. 1: 352 (1891). — **Type citation:** "Murray - scrub, Dr. Behr." **Lectotype (here designated):** [?near] Murray-scrub, [*H.H. Behr*], (MEL 84769, ex herb. Sond.). **Isolectotype:** Murray scrub, [*H.H.*] *Behr* (MEL 85007).

Annual *herb* with ascending to erect major branches c. 6–45 cm long and usually developing minor branches from upper nodes; branches somewhat angular, hairy. *Leaves* usually alternate, but at least sometimes the lowermost opposite, all leaves commonly oblanceolate, sometimes elliptic to narrowly elliptic or narrowly oblong to linear or lanceolate, 5–63 mm long, 2–5 mm wide, often dilated and sheathing at the base and variably decurrent, midrib distinct in the upper surface, the uppermost leaves with a hyaline appendage at the apex, all leaves tomentose. *Compound heads* very broadly to broadly ovoid or spheroidal to broadly ellipsoid, 6.5–12 mm long, 6.5–9 mm diam.; general involucre inconspicuous and represented by a few capitular-like bracts; general receptacle cylindrical to narrowly oblong, consisting of a single, hairy major axis with the capitula scattered more or less evenly along its entire length. *Capitula* c. 50–100. *Capitular bracts* 7–10, obovate, ovate or somewhat elliptic, mainly hyaline but the uppermost portion constricted and shades of yellow or white, with an opaque green or brown midrib which extends c. ⅔ the length of the bract, the entire bract gradually tapered to the base or somewhat abruptly attenuated in the lower ¼, all bracts with long hairs extending from near the apex of the midrib but the margins entire, all bracts flat to conduplicate, 1.7–3.5 mm long, 0.5–0.9 mm wide, arranged in 2 rows. *Florets* 1–3, bisexual. *Corolla* 5-lobed; lobes with slightly thick margins and with papillae on inner surface; tube 1.1–2.3 mm long; inner epidermal cells of lobes and throat with straight walls, the cells not in distinct rows, those of the lobes much smaller than the elongate cells of the tube; vascular tissue not or barely extending to the base of the lobes. *Style* with 2 distinct vascular traces from the base, nectary annular, branches truncate, c. 0.26–0.48 mm long, apices papillate. *Stamens* 5; anthers c. 1–1.2 mm long, caudate; microsporangia c. 0.8–1.0 mm long; apical appendages subtriangular, c. 0.15–0.28 mm long; filament collar more or less straight in outline but slightly dilated towards the base. *Cypselas* obconic, 0.6–1 mm long, 0.35–0.4 mm diam., brown, epidermis myxogenic and with globose myxogenic twin hairs which lack (or have very short) basal cells (stalked ?glandular hairs present near the apex of immature fruit); pericarp lacking sclerenchyma (*P.S. Short 3024*); vascular bundles in pericarp 2; carpopodium absent, the abscission area not differentiated from the pedicel. *Pappus* of c. 6–8 long-plumose, bristle-like structures which are basally united into a cup-like structure. *Chromosome number*: unknown.

*Distribution*. Broadly-confined to south-eastern, mainland Australia, with the species centred in north-eastern Victoria and southern New South Wales and common along much of the southern part of the Murray River drainage basin but with disjunct populations in northern New South Wales, southern Queensland and central-eastern South Australia.

*Habitat*. Commonly grows on heavy clay and scalded soils in myall, red gum and black box woodlands and also recorded for saltbush and grassland communities which are often inundated. It has also been recorded as a weed of crops (Cunningham et al. 1981), including barley (*R.W.Baker*, NSW149626).

*Phenology & reproductive biology*. Cunningham et al. (1981) recorded that germination usually occurs in autumn but maximum growth and flowering occurs

when the soil begins to dry out. Specimen data indicates that flowering occurs from about October to March.

Pollen:ovule ratios determined from five individuals of *P.S. Short 2979*, collected near Wentworth, N.S.W., ranged from 5,144 to 5,707 ($\bar{x}$ = 5,400; s.d. = 220; s.e. = 110).

*Typification*. There are two specimens at MEL which I believe should be considered to come from a single gathering by Dr H.H. Behr and be authentic type material of the name *Leucophyta citrea* Sond. Only one of these is labelled as having been part of Sonder's herbarium and accordingly has been chosen by me as the lectotype specimen; it consists of five elements from one or more plants and a hand-written label which, on the front, records the locality as Murray-scrub and, on the back, has part of a hand-written description headed "*Leucophyta citrea* S." The isolectotype specimen consists of a single element which, in general appearance, strongly matches that of the lectotype specimen, and has a handwritten label indicating that it was collected by Behr from the Murray scrub, that it was seen by Bentham, and gives three (one unpublished) names for the specimen, including *Leucophyta citrea* Sond. and the new name chosen by Mueller, *Calocephalus sonderi*.

*Notes*. There are some marked disjunctions in the distribution of the species, i.e. Andamooka–Stuart Creek region (e.g. *F.J. Badman 3605* & *3842*) in South Australia, southern Queensland, northeast New South Wales, and north-west New South Wales populations are all somewhat discrete from each other and from the more southerly populations in New South Wales, Victoria and South Australia. There are few, if any features, by which the different populations can be distinguished but specimens from the Narrabri–Kootingal region of New South Wales, e.g. *Baker* (NSW 149626), *J.H. Maiden* (NSW 139021), *P.S. Short 3024*, have white bracts, whereas specimens with yellow bracts as found elsewhere. The *Mulham W902* (NSW) and *Baeuerlen* (*NSW 139035*) collections from the Tibooburra region of New South Wales and Andamooka–Stuart Creek differ from the more common southern form in that they have generally larger compound heads and involucral bracts and the terminal lamina of the bracts are often more brightly coloured. At least to some extent, size differences may simply reflect favourable growing seasons when they were gathered. In any case, I have opted to refer all specimens to a single, somewhat variable species.

Jacobs & Pickard (1981) referred to a taxon they called "*C.* sp. aff. *sonderi*". This is the form with white bracts and as noted above, and by Brown (1992), formal recognition of this entity does not seem warranted.

A note accompanying the specimen *G.A. Crawford 110* (NSW), collected in 1950, records that the species grows extensively on the heavy soils of the Wakool Irrigation District, that it appears to have "no fodder value" and that it is locally known as "Poverty weed". Cunningham et al. (1981, p. 706) noted that young plants may be "sparingly grazed" but "older plants are shunned by stock", perhaps due to its "strong aroma when bruised or damaged".

*Selected specimens examined.*

South Australia: Paisley Ck, Stuart Creek Stn, 28 Sep. 1989, *F.J. Badman 3842* (AD); 10 miles upstream from Renmark, 30 Nov. 1968, *W.R. Barker 712* (AD).

Queensland: 20 miles N of Nindigully, 1 Dec. 1958, *L.H. Arnold* (AD 95909102, BRI 013404).

New South Wales: near Deniliquin, 5 April 1952, *E. Gauba* (CBG 015414); 40 km E of Tibooburra, Aug. 1976, *W.E. Mulham W902* (NSW); 7 km from Wentworth along road to Renmark, 28 Oct. 1986, *P.S. Short 2979* (AD, MEL, NSW); 16 km W of Pilliga, 31 Oct. 1986, *P.S. Short 3024* (AD, NSW, MEL).

Victoria: Two Mile Swamp Wildlife Res., 27 Dec. 1985, *A.C. Beauglehole 83018* (CANB, MEL); Barmah State Forest, 2 Jan. 1986, *A.C. Beauglehole 83622* (CANB, HO, MEL); Shire of Dimboola, 7 Jan. 1898, *F.M. Reader* (MEL 85005).

### ***Gilruthia* Ewart**

Proc. Roy. Soc. Victoria 22(1): 14 (1909). — **Type:** *G. osbornii* Ewart & Jean White

Annual *herb*; major branches prostrate to ascending, cottony, with long septate hairs. *Leaves* mainly alternate but the lowermost opposite, entire, the uppermost with a small, hyaline apex, all leaves cottony, the long, septate hairs with broad, flat bases. *Compound heads* absent, capitula solitary or in terminal clusters. *Capitula* homogamous. *Capitular bracts* in about 5 rows, differentiated into a distinct claw and terminal lamina; claw mainly hyaline except for a midrib extending c. the length of the claw and bracts united in each row by long, intertwined hairs at the apex of the midrib. *Receptacle* somewhat conical, lacking receptacular bracts, glabrous. *Florets* bisexual. *Corolla* 5-lobed; lobes with thick margins and their inner surfaces papillate at the base; inner epidermal cells of lobes with more or less straight walls, those of the tube undulate, cells not in distinct rows; vascular strands in the tube 5, each extending to a sinus between two lobes. *Stamens* 5; anthers caudate; apical appendage triangular and thickened centrally and at the apex; filament collar more or less straight in outline but dilated towards the base. *Style* with 2 distinct vascular traces from the base, nectary annular; branches apically papillate. *Cypselas* monomorphic, obovoid, enveloped by a whitish-translucent layer of myxogenic cells; pericarp lacking a layer of sclerenchyma; vascular bundles in pericarp 2; carpopodium annular. *Pappus* c. the length of the corolla, tubular for ¼–¾ its length but the upper part divided into irregularly long-plumose bristles. *Chromosome number*: $n = 13$.

*Distribution*. Endemic to Western Australia.

*Etymology*. The generic name and the specific epithet were named for two of Ewart's colleagues at Melbourne University, Professor John Anderson Gilruth (1871–1937) and Professor William A. Osborne (1873–1967).

*Notes*. A very distinctive taxon and only treated here because of the previous recognition of *Calocephalus skeatsianus* Ewart & Jean White, a synonym of *Gilruthia osbornii*. That the same authors attributed the same taxon to different genera and published the names less than a year apart presumably reflects the fact that the material of *C. skeatsianus* examined by them had generally not reached anthesis.

Grieve & Blackall (1975), recognised *Calocephalus skeatsianus* and noted, at the end of their index to scientific names, that at the time of the completion of the book's manuscript in 1972, representative specimens of *Gilruthia osbornii* at PERTH were unknown to them; material originally identified as this species was housed under *Rhodanthe maryonii* (S.Moore) Paul G.Wilson. Grieve (1982) subsequently added *G. osbornii* to the supplement of Grieve & Blackall (1975). He made no note about the similarity of specimens referred to *C. skeatsianus* and *G. osbornii* and both species were also recognised in Green (1985). However, when recognising monotypic *Gilruthia*, Anderberg (1991) — referring to correspondence from Paul G.Wilson (PERTH) — cited the name *C. skeatsianus* as being a possible synonym of *G. osbornii*. I don't doubt that only one species is involved.

The presence of distinct capitula, not compound heads, is an obvious feature by which to distinguish this taxon from all others which have at some time been placed in *Calocephalus s.lat.*

**1. *Gilruthia osbornii* Ewart & Jean White**

Proc. Roy. Soc. Victoria 22(1): 14, pl. 7 (Sep. 1909); Grieve, How Know W. Aust. Wildfl. Part IV, Suppl. 75 (1982). — **Type citation:** "Mt. Malcolm (north of Kalgoorlie), West Australia, F. Rodway, 123, Nov., 1906." **Holotype:** Mt. Malcolm, Nov. 1906, *F.A. Rodway 123* (MEL 1592447).

*Calocephalus skeatsianus* Ewart & Jean White, Proc. Roy. Soc. Victoria 22(2): 317, pl. 57 & 58, figs 5 & 6 (April 1910) (as "*skeatsiana*"); Grieve & Blackall, How Know W. Austral. Wildfl. 822 (1975). — **Type citation:** "Watheroo Rabbit Fence, West Australia. M. Koch. Dec. 1906. No. 1544." **Presumed syntype:** Watheroo Rabbit Fence, Aug. 1906, *M. Koch 1544* (MEL 543284). **Presumed isosyntype:** PERTH and perhaps MEL 543285 p.p. (see notes below).

Annual *herb*; major branches prostrate to ascending, c. 2–23 cm long, with branching at basal and upper nodes, all branches cottony, with long septate hairs. *Leaves* mainly alternate but the lowermost opposite, entire, obovate to oblanceolate or elliptic or linear, 4–16 mm long, 0.5–1.8 mm wide, mucronate, the uppermost with a small, hyaline apex, all leaves cottony, with long, septate hairs with broad, flat bases. *Capitula* solitary or remaining distinct but with 2–4 (8) in a terminal cluster. *Capitular bracts* in about 5 rows; claw widely obovate to obovate or almost obtriangular, 1.7–3.3 mm long, 1.1–1.6 mm wide; terminal lamina depressed to widely depressed ovate or somewhat shallowly deltate, 0.7–0.9 mm long, 1–1.4 mm wide, mainly pale yellow-brown but may be streaked pink-purple. *Florets* 9–19. *Corolla* lobes with thick margins and their inner surfaces papillate at the base; tube 1.9–2.4 mm long; inner epidermal cells of lobes with more or less straight walls, those of the tube undulate, cells not in distinct rows; vascular tissue extending to the base of the lobes. *Stamens* 5; anthers c. 1.2–1.4 mm long, caudate; microsporangia c. 1–1.1 mm long; apical appendage triangular, c. 0.26–0.33 mm long, thickened centrally and at the apex; filament collar more or less straight in outline but dilated towards the base. *Style* with 2 distinct vascular traces from the base, nectary annular, branches c. 0.6–0.9 mm long, apices papillate. *Cypselas* obovoid, 1–1.2 mm long, 0.7–0.85 mm diam., appearing brown but enveloped by a whitish-translucent layer of myxogenic cells; pericarp lacking a layer of sclerenchyma (voucher information lost); vascular bundles in pericarp 2; carpopodium annular. *Pappus* c. the length of the corolla, tubular for ¼–¾ its length but the upper part divided into 6–11 irregularly long-plumose bristles. *Chromosome number*: $n = 13$.

*Distribution*. Western Australia, between latitudes 26º and 32ºS, and west of longitude 123ºE.

*Habitat*. A herb of semi-arid and arid zone *Acacia*- and *Eucalyptus*-dominated shrublands and woodlands on sand or sandy loam.

*Phenology & reproductive biology*. Flowering specimens have been collected from August to November. Specimens gathered in August, as with the type specimen of *C. skeatsianus*, are often barely flowering and the capitula are shorter than at anthesis; those collected in November have mature or near-mature fruit.

A pollen:ovule ratio of 4,724 was determined for a single floret from *B. Smith 462* (MEL), collected from Mt Gibson.

*Cytology*. Watanabe et al. (1999) recorded $n = 13$ for a population (*P.S. Short 4198*) 20 km from Mount Magnet along the road to Sandstone.

*Typification*. The holotype specimen of *G. osbornii*, MEL 1592447, consists of two plants mounted on the one sheet.

Max Koch used species numbers, not collection numbers, and at MEL there are three specimens of *M. Koch 1544*. Two of these have original collector's labels and have the locality Watheroo Rabbit Fence. Thus, MEL 543284 appears to be annotated in Ewart's, or possibly White's hand, as "*Calocephalus Skeatsiana*" and the word "Type" is pencilled in the top right corner; however, the date of collection is given as "iix. 1906", i.e. as August 1906, not December 1906, as in the protologue. A duplicate of this specimen is held at PERTH. The sheet MEL 543286 appears to be labelled by Ewart or White as "*Calocephalus Skeatsiana* Ewart & White" and has the word "Type" pencilled in the top right corner; however, this specimen is at variance with the protologue, being dated as "iix.1905", i.e. as August 1905, and the note from Koch that "You may find a few better developed flowers among these specimens" also

indicates that it is a separate gathering from that of 1906 and therefore has no type status. (According to my notes made in 1985 there are also two sheets of the Aug. 1905 collection at K, with one not being in a type folder; as of Feb. 2016 there is only one specimen K 000901835 on the Kew Herbarium Catalogue website.) The third sheet at MEL, MEL 543285, comprises several elements of the same taxon, including material in an envelope; a note attached when the specimen was data based states that "This sheet was found unlabelled in association with the two labelled sheets of type material, now mounted as MEL 543254 and MEL 543286." Photocopies of both the original labels on MEL 543254 and MEL 543286 are also attached to this sheet; it is not possible to tell whether the elements are part of the 1905 or 1906 collections or a mixture of both.

All of the aforementioned specimens have immature capitula and appear to lack florets; some "digging" amongst the most mature capitula may reveal some immature florets. This apparent lack of mature florets is consistent with the illustration of an unopened floret in the original description (pl. 57, fig. 4) and Koch's note attached to MEL 543286 regarding the possibility of better-developed florets in that specimen.

Label information and that provided in the protologue do not completely match for any of the aforementioned specimens. However, annotations do indicate that all MEL specimens, and presumably the PERTH specimen with the original Melbourne herbarium label, were examined by Ewart and White. Following the protologue those specimens gathered in 1905 do not have type status. On the other hand, I think it likely that the month "iix" of the 1906 specimen was simply misread as December, not August (a date also consistent with the immaturity of the plants), and have therefore listed MEL 543284 as a "presumed" syntype specimen and the duplicate PERTH specimen as a "presumed" isosyntype specimen of the name *Calocephalus skeatsianus*. Perhaps MEL 543285 may also contain some duplicate material.

*Selected specimens examined.*

Western Australia: 12 km SW of Paynes Find, 13 Nov. 1984, *L. Haegi 2655* (AD, MEL, PERTH); 30 km S of Billabong Roadhouse, 17 Oct. 1983, *P.S. Short 2118* (MEL); 31 km from Yalgoo towards Paynes Find, 21 Oct. 1983, *P.S. Short 2162* (MEL, PERTH); 32 km N of Cleary, 12 Nov. 1983, *P.S. Short 2372* (AD, MEL, PERTH); Youangarra Stn, 26 Aug. 1970, *P.G. Wilson 8872a* (PERTH).

### *Gnephosis* Cass. s.str.

Bull. Sci. Soc. Philom. Paris 43 (1820); DC., Prodr. 6: 151 (1838); P.S.Short, Muelleria 6: 317–319 (1987); A.Anderb., Opera Bot. 104: 130 (1991) p.p., excluding *G. acicularis*; P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 808 (1999). — **Type:** *G. tenuissima* Cass.

*Chrysocoryne* Endl., Bot. Zeitung (Berlin) 1: 457 (1843). — **Type:** *C. drummondii* A. Gray [= *Gnephosis drummondii* (A.Gray) P.S.Short]

*Pachysurus* Steetz, Pl. Preiss. 1: 441 (1845). — **Type:** *P. angianthoides* Steetz [= *Gnephosis angianthoides* (Steetz) A.Anderb.]

[*Angianthus* auct. non Wendl: Benth., Fl. Austral. 3: 561 (1867), as to *A. myosuroides* (= *G. uniflora*), *A. pusillus* (= *G. tenuissima*) & *A. tenellus* (= *G. drummondii*); also in various State and regional floras which followed Bentham.]

Annual *herbs*, the stem simple and sometimes flexuose in small plants but usually forming major branches at near-basal and upper nodes; a sparse to dense cover of scale-like glandular hairs usually present on branches and leaves, only *Gnephosis cassiniana* glabrous. *Leaves* sessile, entire, alternate, not or slightly succulent (particularly *G. cassiniana*). *Compound heads* narrowly ellipsoid to obloid, obovoid or cylindrical to oblong; general involucre not or barely developed, a few leaf-like bracts with hyaline apices may be present. *Capitula* c. 6–250, usually each subtended by a bract (capitulum-subtending bract) manifestly distinct from the capitular bracts. *Capitular bracts* in 1, 2 or 3 rows, some species (*G. drummondii*, *G. tridens*, *G. trifida*, *G. uniflora*) with only 2 bracts, but as many as c. 13 in other species; sometimes differentiated into a distinct claw and terminal lamina but usually not so, often with

**Key to species of *Gnephosis* s.str.**

**1.** Inner capitular bracts with a prominent c. 0.4–0.5 mm long, yellow terminal lamina ..... **1. *G. angianthoides***
**1:** Inner capitular bracts lacking a prominent terminal lamina, or if at all developed then not yellow but the same pale brownish as the marginal lamina
  **2.** Plants glabrous; leaves somewhat succulent; pappus absent ..... **2. *G. cassiniana***
  **2:** Plants with scale-like hairs; leaves barely ever even slightly succulent; pappus present or absent
    **3.** Capitular bracts 2–6 (c. 10); capitula with (2) 3–5 (8) florets
      **4.** Pappus absent; capitular bracts with ciliate margins; corolla 3–5-lobed ..... **4. *G. multiflora***
      **4:** Pappus present (often a small jagged ring but sometimes with several apically divided bristles); capitular bracts with entire margins; corolla 5-lobed ..... **3. *G. tenuissima***
    **3:** Capitular bracts 2; capitula usually with 1 or 2 florets (rarely 3 or 4 in *G. drummondii*)
      **5.** Midrib of capitulum-subtending bracts with at least 3 distinct lobes ..... **6. *G. trifida***
      **5:** Midrib of capitulum-subtending bracts not divided
        **6.** Corollas mainly 5-lobed; anthers usually 5 ..... **5. *G. uniflora***
        **6:** Corollas 3- or 4-lobed; anthers 3 or 4
          **7.** Compound heads narrowly oblong, c. 1–2.5 cm long; florets (1) 2 or 3 (4) per capitulum (W.A., S.A., Vic.) ..... **7. *G. drummondii***
          **7:** Compound heads narrowly oblong to cylindrical, (c. 1) 3–6 cm long (W.A.) ..... **8. *G. tridens***

long marginal hairs. *Receptacle* conical, glabrous. *Florets* bisexual, 1–c. 16 (only 1 in *G. tridens* and 1 or 2 in *G. trifida* and *G. uniflora*). *Corolla* tubular, 3-, 4- or 5-lobed. *Stamens* 3, 4 or 5, anthers caudate, with apical appendages. *Cypselas* monomorphic, obovoid, purplish, thin-walled, with scattered globose, myxogenic hairs (papillae); carpopodium annular. *Pappus* absent or present (*G. angianthoides* & *G. tenuissima* only), being a small jagged ring or of apically divided bristles or scale-like bristles joined at the base. *Chromosome numbers*: $n = 14$, c. 13, 12, c. 11, 6.

*Distribution*. Australia, with six of the eight species only in Western Australia. Maps showing the distribution of most species can be seen in Short (1981a, p. 402, fig. 4, as spp. of *Chrysocoryne*). There is a tendency for some species to be restricted to particular drainage systems in south-western Western Australia.

*Etymology*. The origin of this name is unclear. Possible derivations were noted by Baines (1981).

*Cytology*. *Gnephosis* s.str. is one of many Australian genera with an apparent base number of $x = 14$ and exhibiting infrageneneric dysploidy, an observation which led to the suggestion that $x = 14$ may be the base number for the tribe in Australia (Watanabe et al., 1999).

*Note*. The relationships of many of the species within *Gnephosis* s.lat. are unclear and the suggestion that *Gnephosis* s.str. comprises the species here placed within it is open to question. However, all species except *G. angianthoides* have a single capitulum-subtending bract that is morphologically distinct from the upper leaves and the capitular bracts, and all except *G. cassiniana* have a sparse to dense indumentum of scale-like glandular hairs. Indeed, the delimitation is not too dissimilar to that suggested by Anderberg (1991) who noted of *G. angianthoides* that, in having "a less reduced capitular [bract] arrangement … is … probably the most plesiomorphic taxon of the genus" (Anderberg 1991, p. 130); the same argument allows for the inclusion of *G. cassiniana*. The circumscription here used differs from Anderberg in that I exclude *G. acicularis* and *Hyalochlamys globifera* A.Gray on the basis of bract and cypsela morphology. Contrary to their earlier inclusion (Short 1990c) I here exclude *G. setifera* and *G. brevifolia* from *Gnephosis* s.str. — among other things they differ in lacking capitulum-subtending bracts and scale-like hairs — but in doing so reiterate that further investigations are required to substantiate this view.

The possible relationships of most of the species here referred to *Gnephosis* s.str. were schematically displayed when I treated them as members of *Chrysocoryne* (Short 1983, p. 186, fig. 9). What is now *G. tenuissima* (with multiple bracts and florets) was at the base and I illustrated a progressive loss in bract and floret number, along with change in corolla lobe number and levels of pollen production. There were also some changes in bract morphology. Using primarily these same characters, and also including *G. angianthoides* and *G. cassiniana*, unpublished cladistic analyses by me supported similar relationships which are reflected in the order of treatment followed here.

**1. *Gnephosis angianthoides* (Steetz) A.Anderb.**

Opera Bot. 104: 130 (1991). — *Pachysurus angianthoides* Steetz in Lehm., Pl. Preiss. 1: 442 (1845). — *Calocephalus angianthoides* (Steetz) Benth., Fl. Austral. 3: 575 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 821 (1975). — *Leucophyta angianthoides* (Steetz) Kuntze, Revis. Gen. Pl. 1: 352 (1891). — **Type citation:** "In arenosis subumbrosis ad radicem montis Eliza, d. 25. Oct. 1839. Herb. Preiss. No. 44." **Lectotype (here designated):** MEL 543264 (ex herb. Steetz). **Isolectotypes:** G-DC (G 00222880), K 000901847 (ex herb. Hook. 1867), LD 1014325, MEL 543265, MEL 543266 (ex herb. Sonder), MEL 543267 (ex herb. Sonder), P 00698994, P 00715988, P 00715959 (ex. herb. Schultz-Bip.), S.

*Calocephalus priceanus* Domin, Vestn. Kral. Ceske Spolecn. Nauk., Tr. Mat.-Prir. 2: 121 (1923). — **Type citation:** "W.A.: coll. W. H. Ince." **Holotype:** K 000901836.

Annual *herb*, the stem simple and often flexuose in the smaller plants but usually forming major branches at near-basal and upper nodes; major branches 2.5–20 cm long, usually ascending to erect, sometimes decumbent, reddish or purple-brown, with a sparse to dense cover of scale-like glandular hairs and the upper part usually with a cottony indumentum. *Leaves* sessile, entire, elliptic to narrowly elliptic or obovate to oblanceolate, 2.2–19 mm long, 1.1–3.4 mm wide, the basal ones in a rosette, cauline leaves alternate, all leaves often somewhat succulent and with a sparse to dense indumentum of scale-like hairs, the upper leaves sometimes cottony. *Compound heads* narrowly ellipsoid to obloid, 4.5–27 mm long, 5–11 mm diam., general involucre absent but each of the lower capitula subtended by a single, mainly foliaceous bract; *general receptacle* branched, sparsely cottony, each secondary peduncle terminating in 1–4 capitula. *Capitula* 8–280 per compound head, each one usually subtended by a bract, the lower capitulum-subtending bracts mainly foliaceous, the upper hyaline except for a midrib extending for c. ⅔ the length. *Capitular bracts* in 2 rows. *Outer bracts* c. 6 or 7, mainly hyaline except for a midrib extending for c. 3/4–4/5 the length of the claw, all bracts united by long intertwined hairs at the apex of the midrib and base of the terminal lamina; claw elliptic or obovate, 1.4–1.7 mm long, 0.8–0.9 mm wide; terminal lamina widely depressed to depressed ovate, 0.3–0.5 mm long, 0.5–0.6 mm wide, more or less distinguished by a constriction above the midrib but otherwise resembling the hyaline margins of the claw. *Inner bracts* c. 5 or 6, entirely hyaline or sometimes with an indistinct midrib extending to c. ⅓ the length of the claw, all bracts united by long, dense, intertwined hairs at the base of the terminal lamina; claw obovate or elliptic, 1.4–1.7 mm long, 0.7–0.9 mm wide; terminal lamina widely depressed to depressed ovate, 0.4–0.5 mm long, 0.45–0.75 mm wide, somewhat

concave, slightly reflexed, yellow. *Receptacle* conical, glabrous. *Florets* 1–11, bisexual. *Corolla* tubular, 5-lobed; lobes with slightly thick margins, papillate at the base of the lobes; tube 1–1.2 mm long; inner epidermal cells of lobes with more or less straight walls, those of the throat with undulate margins, the cells not in distinct rows; vascular tissue barely extending to the base of the lobes. *Style* with 2 distinct vascular traces from the base, nectary annular, branches truncate, c. 0.28–0.32 mm long, apices papillate. *Stamens* 5; anthers c. 0.55–0.65 mm long, distinctly caudate; microsporangia c. 0.4–0.5 mm long; apical appendages triangular, c. 0.15 mm long; filament collar more or less straight in outline but slightly dilated towards the base. *Cypselas* obovoid, 0.4–0.5 mm long, 0.25–0.3 mm diam., purple, with globose, myxogenic twin hairs which seemingly lack a basal cell; vascular bundles in pericarp 2; carpopodium annular. *Pappus* of 3–7 scale-like bristles about the length of the corolla, joined at the base, the upper part of the bristles irregularly long-plumose. *Chromosome number*: $n = 14$.

*Distribution*. South-western Western Australia, west of 124º E and south of 26º S but excluding the wet-forest areas of the extreme South-west.

There is a collection *R. Bates 4718* (AD) labelled as being collected on 29 October 1984 from Coolanie Valley, Eyre Peninsula, South Australia. However, apparent labelling discrepancies for other specimens Bates collected in that month — as gleaned from AVH together with the fact that he was collecting in W.A. just a couple of days before he apparently collected on Eyre Peninsula, suggest he also gathered this specimen in that State. Perusal of his other collection localities from that time, plus my knowledge of the distribution of this species, suggests the specimen was gathered at Newman Rocks, W.A., a locality at which it is particularly common. Unless other specimens substantiate its presence *G. angianthoides* should not be recorded for S.A.

*Habitat*. The species tends to grow on the margins of salt lakes or in samphire flats, as indicated by the following collectors' notes: "in sand amongst samphire and *Melaleuca*", "low lying samphire flats with scattered shrubs of *Lycium australe*, *Dodonaea*, *Atriplex spongiosa* ... reddish brown sandy loam", "amongst samphire and *Frankenia*" and "in sandy loam amongst samphire and *Gunniopsis*". It has also been recorded as growing in shallow depressions of granite outcrops and for one specimen it is recorded as growing "in red sandy soil with [*Eucalyptus*] *loxophleba*".

*Phenology & reproductive biology*. Mostly flowering from about late September to November, with fruiting from about mid-November to December. Several flowering or near-flowering specimens have been gathered in August and one also in May.

Pollen:ovule ratios ranging from 1,700 to 1,823 ($\bar{x}$ = 1,771; s.d. = 44; s.e. = 22) were determined from five florets from *P.S. Short 1765*, collected at Newman Rocks.

*Cytology*. Watanabe et al. (1999) recorded $n = 14$ from a population (*P.S. Short 4071*) about 13 km north of Carnamah along the road to Three Springs, W.A.

*Notes*. Typically, the inflorescence is a compound head consisting of a dense cluster of capitula, each head terminating a branch. Sometimes the lower capitula are not strongly aggregated with the others and are comparatively poorly developed, having only one or two florets each and with fewer and less-differentiated bracts than normal.

*Selected specimens examined.*

Western Australia: Mongers Lake, 23 Sep. 1980, *H. Demarz 8284* (KPBG); Hammersley Lakes system, 4 Nov. 1983, *L. Haegi 2564 & P.S. Short* (AD, MEL, PERTH); Newman Rocks, 19 Sep. 1982, *P.S. Short 1765* (MEL); "The Boats", c. 27 km from Laverton along road to Leonora, 9 Oct. 1983, *P.S. Short 2008* (MEL, PERTH); Lake Ninan, 25 Oct. 1983, *P.S. Short 2216* (AD, MEL, PERTH).

### 2. *Gnephosis cassiniana* P.S.Short

Muelleria 7: 242, fig. 1 (1990). — **Type citation:** "Holotypus: Western Australia, c. 2.5 km S of Binnu along Geraldton road … 20.ix.1983, [*P.S*] *Short* 2134 (MEL 693806). Isotypi: AD, CANB, MEL (wet colln), NSW, PERTH." AVH [avh.ala.org.au, accessed 9 July 2015] lists: **Holotype:** MEL 0693806A. **Isotypes:** AD 98930048, CANB 394473, MEL 2164883A (spirit), PERTH 1063154. (NSW not listed).

Erect *herb* to c. 6 cm tall, simple or branched, glabrous. *Leaves* mostly elliptic or ovate but sometimes linear or oblanceolate, 3.5–12 mm long, 0.6–2.4 mm wide, succulent, glabrous. *Compound heads* ellipsoid or obovoid, 3.5–12 mm long, 2.5–8 mm diam. *Capitula* (2) 6–30. *Capitulum-subtending bract* 2.8–3.8 mm long, entire bract leaf-like or with narrow, entire, hyaline margins. *Capitular bracts* 9–12, an outer pair of mostly green bracts surrounding 1 or more inner whorls of mostly hyaline bracts, all bracts with long hairs on the margins. *Florets* 4–16; corolla 5-lobed; lobes with slightly thickened margins, papillate at the base of each lobe; inner epidermal cells of lobes with more or less straight walls, those of the throat with almost straight or slightly undulate margins, the cells not in distinct rows; vascular tissue extending to the base of the lobes. *Anthers* 5, each with c. 300 pollen grains; microsporangia c. 0.58–0.66 mm long; terminal appendage somewhat narrowly triangular but apically obtuse. *Cypselas* obovoid, 0.4–0.5 mm long, pink. *Pappus* absent. *Chromosome number*: unknown. **Fig. 2A.**

*Distribution*. South-western Western Australia, around the margins of saline depressions near Binnu and Pindar and from Mongers Lake.

*Phenology & reproductive biology*. Flowering is recorded for September (as per specimens examined to 1990).

A pollen:ovule ratio of 1,560 (Short 1990c) determined from a single floret from *P.G. Wilson 12298* is suggestive of cross-pollination but also self-compatibility.

*Habitat*. Only noted as growing with *Tecticornia* spp. in sand.

*Selected specimens examined.*

Western Australia: c. 10 km W of Pindar, 13 Sep. 1986, *P.S. Short 2881, M. Amareena & B.A. Fuhrer* (AD, MEL, PERTH); c. 0.5 km N of Pindar, 8 Sep. 1995, *P.S. Short 4365* (MEL); 6 km S of Warriedar Hmsd near west bank of Mongers Lake, 26 Sep. 1986, *P.G. Wilson 12298* (MEL, PERTH).

**3. *Gnephosis tenuissima* Cass.**

Bull. Sci. Soc. Philom. Paris 43 (1820); P.S.Short in N.G. Walsh & Entwisle, Fl. Victoria 4: 808, fig. 162a (1999). — **Type citation:** "… Nouvelle-Hollande … au port Jackson, à la baie des Chiens-Marins." **Lectotype:** Port Jackson, New Holland, *coll. unknown* (P 00698997, annotated by Cassini) (Short 1987b, p. 318). **Isolectotype:** P 00698998. **Possible isolectotype or possible remaining syntype:** Habitat in novaehollandia (P 00715965, ex herb. A.N. Desvaux); no locality (P00715966, annotated by Cassini). **Remaining syntype:** Shark Bay, voyage of Captain Baudin (P 00698996).

*Crossolepis pusilla* Benth. in Endl. et al., Enum. Pl. Huegel 61 (1837); P.S.Short, Muelleria 5: 189, figs 9 p.p., 10 af (1983). — *Chrysocoryne pusilla* (Benth.) Endl., Bot. Zeitung (Berlin) 1: 458 (1843). — *Chrysocoryne huegelii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 151 (1851), nom. illeg. — *Angianthus pusillus* (Benth.) Benth., Fl. Austral. 3: 564 (1867); O.Hoffm. in Engler & Prantl, Nat. Pflanzenfam. IV(5): 194, fig. 98CG (1890). — *Siloxerus pusillus* (Benth.) Kuntze, Revis. Gen. Pl. 367 (1891) (as *Styloncerus*, orthographic variant of *Siloxerus*); *Siloxerus pusillus* (Benth.) Ising, Trans. & Proc. Roy. Soc. South Australia 46: 604 (1922), comb. superfl. — **Type citation:** "Swan River. (Hügel.)." **Lectotype:** Swan River, W.A., *K.A.A.F. Hügel* (W 0047218) (Short 1983, p. 189). **Isolectotype:** K 000901791.

*Angianthus pusillus* var. *polyanthus* Benth., Fl. Austral. 3: 564 (1867). — **Type citation:** "Murray and Darling desert." **Lectotype:** Murray & Darling desert, Victorian Expedition (K 000901792) (Short 1983, p. 190). **Possible isolectotypes:** near R. Darling, Victorian Expedition, *Dr. Beckler* (K 000901798); Darling Desert, *Anon.* (MEL 541203); near Darling R., 28 Oct. 1860, Vict. Exepd. (MEL 541204); near R. Darling, V. Exped., *Beckler* (MEL 84537); sand hills, 29 Sep. 1860, Vict. Exped. (MEL 84538).

*Chrysocoryne angianthoides* F.Muell., Linnaea 25: 404 (1853). — **Type citation:** "In virgultis deserti pone Cudnaka." **Lectotype:** in den gestrüppen zwischen Cudnaka & Arkaba, Oct. 1851, *F. Mueller* (MEL 541201) (Short 1983, p. 190). **Isolectotypes:** MEL 541200; MEL 541202. **Probable isolectotypes:** GH 00014319, ex herb. Sond.; MEL 84532, ex herb. Sond.

*Gnephosis* sp. Pt Quobba (*P.G. Wilson 12622*) WA Herbarium, as per florabase.dpaw.wa.gov.au/search/current/18438 [accessed 7 May 2015] and biodiversity.org.au/nsl/services/apc-format/display/237273?product=apc [accessed 9 July 2015].

[*Podolepis divaricata* A.Cunn. ex DC., Prodr. 6: 151 (1838), nom. inval., nom. in sched.]

Annual *herb* usually with ascending to erect branches to 15 cm long, sometimes unbranched, with scale-like glandular hairs. *Leaves* linear or narrowly elliptic to elliptic or oblanceolate to obovate, 2–33 mm long, 0.5–4 mm wide, with scale-like hairs. *Compound heads* narrowly ellipsoid to ellipsoid, oblanceoloid to obovoid or ovoid, 10–22 mm long, 3–7 mm diam. *Capitula* 20–80. *Capitulum-subtending bract* 1.2–2.8 mm long; midrib entire. *Capitular bracts* c. 4–10, in 2 rows, margins entire, not or sometimes with a reasonably well-defined claw and terminal lamina, but if present, the terminal lamina pale brownish as is the lamina of the claw. *Florets* (1) 3–8; corolla 5-lobed. *Anthers* 5, each with c. 300–450 pollen grains. *Cypselas* obovoid, 0.35–0.5 mm long, purplish, papillose. *Pappus* usually a jagged ring 0.1–0.2 mm high, sometimes with several apically divided bristles extending to c. ½ the length of the corolla. *Chromosome number*: $n = 6$.

*Distribution*. Widespread in central and southern mainland Australia (W.A., N.T., Qld, S.A., N.S.W., Vic.).

*Habitat*. Occurs in an array of mostly semi-arid and arid habitats, e.g. on red sand ridges dominated by *Triodia* and species of *Acacia*, amongst *Tecticornia* on the edge of saline depressions, in sandy loam at the base of granite rocks, and in clay loam in chenopod shrubland.

*Phenology & reproductive biology*. Typically flowers about August to November following winter rains, but, for example, in the southern N.T. flowering has been recorded in April.

An average pollen:ovule ratio of 1,967 has been determined for this species (Short 1981a, as *Chrysocoryne pusilla*). Data was obtained from 45 individual plants, with 15 from each of three populations, i.e. *R.J. Chinnock 4335* and *P.S. Short 924* from W.A., and *P.S. Short 902* from S.A.

*Cytology*. Short (1981b, 1983), using the name *Chrysocoryne pusilla*, recorded $n = 6$ for a population (*P.S. Short 834*) from Hesso, S.A., and $2n = 12$ for a population (*P.S. Short 999*) about 90 km north of Geraldton, W.A.

*Notes*. I've previously noted that the locality, Port Jackson, cited for the lectotype specimen is erroneous (Short 1987b) and believe it indisputable that the type was collected at Shark Bay by a member of the Baudin expedition.

As previously noted (Short 1983, as *Chrysocoryne pusilla*) this is a polymorphic taxon exhibiting much variation in habit, the shape of the leaves and compound heads, the structure of the pappus and in the number of bracts and florets per capitulum. I have little doubt that it will be shown to consist of a number of distinctive taxa worthy of recognition, including that first described as *Crossolepis pusilla* Benth.

As noted under the treatment of *G. acicularis*, a specimen *P.S. Short 4439* appears to be referable to this species but has unusually well-developed pappus bristles, these being about the length of the corolla tube and highly and long-dissected.

Despite having mislaid my notes concerning the type specimen of *G. tenuissima*, I believe the phrase name

taxon *Gnephosis* sp. Pt Quobba (*P.G. Wilson 12622*) WA Herbarium is *G. tenuissima* s. str. I'm not aware that I have seen a specimen of *P.G. Wilson 12622*, but in May 2015 viewed specimens which have been attributed to that phrase-name taxon at PERTH, i.e., *A.H. Burbidge 4682*, *J. Docherty 95*, *D. Edinger et al. B 7/11*, *D.M. Porter 284* and *G. Byrne 1731*.

*Selected specimens examined.*

Western Australia: Carnamah, 2 Nov. 1906, *A. Morrison* (CANB 209963, BRI 144628, PERTH); 6 km SW of Paynes Find, 24 Oct. 1984, *M.G. Corrick 9329* (MEL); c. 20 km N of Gascoyne Junction, 24 Aug. 1977, *P.S. Short 464* (AD); Overlander Roadhouse to Denham road, 16 Oct. 1983, *P.S. Short 2099* (AD, MEL, PERTH); c. 8 km S of Sullivan Ck on Leonora to Agnew road, 10 Oct. 1983, *P.S. Short 2014* (MEL, PERTH).

Northern Territory: Curtis Springs Stn, 18 Sep. 1974, *P.K. Latz 5690* (DNA); 32 km SE of Newhaven Hmsd, 6 Sep. 2013, *P.K. Latz 28772 & P. Rilstone* (DNA); 12 miles N of Kulgera Store, 17 Sep. 1968, *A.O. Nicholls 927* (DNA).

South Australia: c. 400 m N of Hesso, 13 Oct. 1979, *P.S. Short 902* (AD).

Queensland: Naryilco Stn, 3 Oct. 1971, *B.J. Copley 3690* (AD).

New South Wales: 12.8 km N of Lake Wallace Hmsd, 26 Sep. 1971, *N.S. Lander 72* (AD, NSW).

Victoria: Kulkyne National Forest, Oct. 1948, *A.C. Beauglehole 1090* (MEL).

### 4. *Gnephosis multiflora* (P.S.Short) P.S.Short

Muelleria 6: 317 (1987). — *Chrysocoryne multiflora* P.S.Short, Muelleria 5: 192, figs 9 p.p., 10 g–h, 11 (1983). — **Type citation:** "Holotypus … [*R.J.*] *Chinnock 4411* & [*P.G.*] *Wilson*, Mortlock River just east of Meckering … 22.xi.1978 (AD 98002346). Isotypus: PERTH." **Holotype:** AD 98002346. **Isotypes:** AD 98126008, MEL 0108109, PERTH 1043951.

Erect *herb* to c. 4 cm tall, simple or branched, with scale-like glandular hairs. *Leaves* elliptic or oblanceolate to obovate or linear, 3–7 mm long, 1–2 mm wide, densely covered in scale-like hairs. *Compound heads* narrowly oblong to oblong, 5–20 mm long, 2.5–4.5 mm diam. *Capitula* 50–250. *Capitulum-subtending bract* 1.8–2.9 mm long, margins sometimes ciliate; midrib entire. *Capitular bracts* 2–4 (10), majority of capitula with 2 concave bracts with ciliate margins and 1 or 2 inner flat bracts with ciliate upper margins, the cilia 0.1–0.3 mm long. *Florets* (2) 3–5 (6); corolla 3–5-lobed. *Anthers* 3–5, each with c. 16–40 pollen grains. *Cypselas* obovoid, c. 0.4 mm long, purplish, papillose. *Pappus* absent. *Chromosome number*: $2n$ = c. 24.

*Distribution*. South-western Western Australia, possibly confined to the Avon River drainage system.

*Habitat*. Probably confined to the sandy soil on the margins of saline depressions.

*Phenology and reproductive biology*. Flowering in about October/November.

An average pollen:ovule ratio of 106 has been determined for this species (Short 1981a, as *Chrysocoryne* sp. A).

*Cytology*. Short (1981b, 1983), using the name *Chrysocoryne multiflora* recorded $2n$ = c. 24 for a population (*P.S. Short 1046*) near Meckering, W.A. **Fig. 2B.**

*Selected specimens examined.*

Western Australia: Western edge of Lake King, 12 Nov. 1978, *R.J. Chinnock 4364* (AD, PERTH); c. 4.6 km E of Meckering, 20 Nov. 1979, *P.S. Short 1046* (AD); salt lake adjacent to Wave Rock, 31 Oct. 1995, *P.S. Short 4531* (MEL).

### 5. *Gnephosis uniflora* (Turcz.) P.S.Short

Muelleria 6: 318 (1987). — *Chrysocoryne uniflora* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24: 188 (27 March 1851); P.S.Short, Muelleria 5: 198, fig. 9 p.p. (1983).— **Type citation:** "Nova Hollandia. Drum coll. III. n.116." **Lectotype (here designated):** KW 001001484. **Isolectotypes:** BM 000810556; GH 00014320/00014321, ex herb. Klatt; K 000901820; K 000901817, colln dated 1845, ex herb. Benth; KW 001001485; MEL 541599; NSW 685758, P: two sheets; TCD. **Probable isolectotypes:** Swan River, *Drummond* (GH 00014322/00014323, K 000901819, MEL 84468, MEL 541598, MEL 541600).

*Chrysocoryne myosuroides* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 152 (May 1851). — *Angianthus myosuroides* (A.Gray) Benth., Fl. Austral. 3: 563 (1867); O.Hoffm. in Engler & Prantl, Nat. Pflanzenfam. IV(5): 194, fig. 98B (1890). — *Siloxerus myosuroides* (A.Gray) Kuntze (as *Styloncerus*, orthographic variant of *Siloxerus* and as "*myosurodes*"). — **Type citation:** "Swan River, *Drummond*, 1845." **Lectotype:** *J. Drummond 116* (K 000901820) (Short 1983, p. 198). **Isolectotypes:** Swan River, *Drummond 116* (BM 000810556; GH 00014320/00014321, ex herb. Klatt; K 000901817; KW 001001484, KW 001001485, MEL 541599, NSW 685758, P: two sheets, TCD). **Probable isolectotypes:** Swan River, *Drummond* (GH 00014322/00014323, K 000901819, MEL 84468, MEL 541598, MEL 541600).

Erect *herb* to 8 (14) cm tall, simple or branched, with scale-like glandular hairs. *Leaves* narrowly elliptic to elliptic, oblanceolate to obovate or lanceolate, 2–8 mm long, 0.5–2 mm wide, with a dense cover of scale-like hairs. *Compound heads* cylindrical to narrowly oblong, 15–44 mm long, 1.5–2.5 mm diam. *Capitula* 50–150. *Capitulum-subtending bract* 1.7–2.1 mm long; midrib entire. *Capitular bracts* 2, concave, upper margins variable ciliate, the cilia less than c. 0.1 mm long. *Florets* 1 or 2; corolla 5-lobed. *Anthers* 5, each with c. 250–350 pollen grains. Cypselas obovoid, 0.4–0.5 mm long, purplish, papillose. *Pappus* absent. *Chromosome number*: unknown.

*Distribution*. South-western Western Australia, from Meckering north to about Pindar.

*Habitat*. Grows in sand or sandy loam in association with *Tecticornia* species and *Melaleuca* on the margins of salt lakes.

*Phenology and reproductive biology*. Flowering about September to November.

An average pollen:ovule ratio of 1,778 has been determined for this species (Short 1981a, as *Chrysocoryne uniflora*), being based on 15 specimens of *P.S. Short 614A*.

*Notes*. In Short (1983), having received on loan a single specimen of *J. Drummond 3:116* from KW, I referred to it as being the holotype specimen of *Chrysocoryne uniflora* (and on the determinavit slip simply referred to it as "Type"). The specimen, consisting of a single element, did not contain an original label but, with Turzaninow's herbarium (with the exception of his Siberian collection) apparently housed in Kiev (e.g. Marchant 1990), I never questioned the status of the specimen. However, having since viewed JSTOR images for this species it is evident that a further specimen exists in KW, this being KW 001001484. The specimen consists of five elements and an original label, most or all of which I believe is in Turczaninow's hand, and has the words, in part, "Chrysocoryne uniflora m[?]: n. sp. capitulis unifloris". Undoubtedly, it should be considered to be the principal type and hence my above designation of it as the lectotype specimen of the name *Chrysocoryne uniflora*. The specimen consisting of a single element, now numbered as KW 001001485, is an isolectotype.

*Selected specimens examined.*

Western Australia: c. 3.4 km E. of Meckering in Mortlock River, 20 Sep. 1977, *P.S. Short 614A* (AD); 7.9 km N. of Latham, 15 Nov. 1979, *P.S. Short 986* (AD, DNA); c. 30.4 km S of Pindar, 15 Nov. 1979, *P.S. Short 991* (AD); c. 54.5 km from Nugadong along main road to Gunyidi, 19 Nov. 1979, *P.S. Short 1014* (AD, DNA); c. 2.5 km S. of Binnu, 20 Oct. 1983, *P.S. Short 2135* (AD, CANB, HO, NSW, PERTH); c. 13 km N of Carnamah, 5 Oct. 1993, *P.S. Short 4070* (AD, MEL, PERTH, S, TI).

### 6. *Gnephosis trifida* (P.S.Short) P.S.Short

Muelleria 6: 318 (1987). — *Chrysocoryne trifida* P.S. Short, Muelleria 5: 196, figs 9 p.p., 10k–m, 12 (1983). — **Type citation:** "Holotypus … [*P.S.*] *Short 966*, 45.1 km N. of Koorda along main road to Mollerin. Salt lake … 14.xi.1979 … (AD 98002348). Isotypus: PERTH." Holotype: AD 98002348. Isotypes: AD 98126013, MEL 0108108, PERTH 1043986.

Erect *herb* to 7 cm tall, simple or branched, with scale-like glandular hairs. *Leaves* oblanceolate or narrowly elliptic to elliptic, 2–8 mm long, 1–2 mm wide, with scale-like hairs. *Compound heads* cylindrical to narrowly oblong, 10–40 mm long, 1–2 mm diam. *Capitula* 30–100. *Capitulum-subtending bract* 1.6–2.2 mm long; midrib with at least 3 distinct lobes. *Capitular bracts* 2, concave, upper margins long-ciliate, the cilia c. 0.5 mm long. *Florets* 1 (2); corolla 5-lobed, lobes with slightly thick margins, seemingly only papillate at the base of 4 lobes; inner epidermal cells of lobes with more or less straight walls, those of the throat with undulate margins, the cells not in distinct rows. *Anthers* 5, each with c. 350–500 pollen grains; microsporangia c. 0.49–0.58 mm long, terminal appendage narrow and somewhat oblong or narrowly triangular but apically obtuse. *Cypselas* obovoid, 0.3–0.4 mm long, purplish, papillose. *Pappus* absent. *Chromosome number*: $n$ = c. 11. **Fig. 2C.**

*Distribution*. South-western Western Australia, from about Perenjori to Lake Barlee.

*Habitat*. Locally common with *Tecticornia* and other salt-tolerant shrubs on the margins of salt lakes.

*Phenology & reproductive biology*. Flowering from about late August to mid-November.

An average pollen:ovule ratio of 2,044 was determined for this species (Short 1981a, as *Chrysocoryne* sp. B), being based on 15 individuals of *P.S. Short 966*.

*Cytology*. Short (1981b, 1983), using the name *Chrysocoryne trifida*, recorded $n$ = c. 11 for a population (*P.S. Short 966*) about 45 km north of Koorda, W.A.

*Selected specimens examined.*

Western Australia: 34.5 km N of Perenjori, 15 Nov. 1979, *P.S. Short 989* (AD); 5 km S of Morawa, 8 Sep. 1995, *P.S. Short 4369* (MEL, PERTH, TI); near Mollerin, 2 Sep. 1967, *P.G. Wilson 6083* (PERTH); Lake Barlee, southern margin, 25 Aug. 1970, *P.G.Wilson 8813* (PERTH).

### 7. *Gnephosis drummondii* (A.Gray) P.S.Short

Muelleria 6: 317 (1987); P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 808, fig. 162b (1999). — *Chrysocoryne drummondii* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 152 (1851); P.S.Short, Muelleria 5: 193, figs 9 p.p., 10ij (1983). — **Type citation:** "Swan River, *Drummond*." **Lectotype:** Swan River, W.A., *J. Drummond 16* (K 000901812) (Short 1983, p. 193). **Possible isolectotypes or remaining syntypes:** *J. Drummond* (K 000901813, MEL 541601); *J. Drummond 356* (MEL 84756; P, two sheets).

*Chrysocoryne tenella* F.Muell., Defin. Austral. Pl. 49 (28 June–12 July 1855), preprint from Trans. & Proc. Victorian Inst. Advancem. Sci. 1854–1855: 130 (10 Sep. 1855), reprinted in Hooker's J. Bot. & Kew Gard. Misc. 8: 149 (1856), see Seberg (1986) for dates of publication. — *Angianthus tenellus* (F.Muell.) Benth., Fl. Austral. 3: 564 (1867). — *Siloxerus tenellus* (F.Muell.) Kuntze, Revis. Gen. Pl. 367 (as *Styloncerus*, orthographic variant of *Siloxerus*); *Siloxerus tenellus* (F.Muell.) Ostenf., Biol. Meddel. Kongel. Danske Vidensk. Selsk. 3: 138 (1921), comb. superfl. — **Type citation:** "In flats subject to inundations by winter rains, between the Long Lake and the Fountain, on Spencer's Gulf. C. Wilhelmi." **Lectotype:** between the Fountain and Long Lake, S.A., *C. Wilhelmi* (K 000901814) (Short 1983, p. 193). **Isolectotype:** TCD, P. **Probable isolectotype or syntype:** MEL 541620.

[*Crossolepis pusilla* auct. non Benth.: Hooker's Ic. Pl. 5: t. 413 (1841).]

[*Chrysocoryne pusilla* auct. non (Benth.) Endl.: Endl., Bot. Zeitung (Berlin) 1: 457 (1843.]

Erect *herb* to 6 cm tall, simple or branched, with scale-like glandular hairs. *Leaves* oblanceolate to obovate or narrowly elliptic to elliptic, 2–11 mm long, 0.4–1 mm wide, usually with a dense cove of scale-like hairs. *Compound heads* narrowly oblong, 5–25 mm long, 2–3.5 mm diam. *Capitula* 40–150. *Capitulum-subtending bract* 1.6–2.3 mm long; midrib entire. *Capitular bracts* 2, concave, upper margins ciliate, the cilia c. 0.1 mm long. *Florets* (1) 2 (4); corolla 3- or 4- (rarely

5-) lobed. *Anthers* 3 or 4 (5), each with 20–60 pollen grains. *Cypselas* obovoid, 0.4–0.5 mm long, purplish, papillose. *Pappus* absent. *Chromosome number*: *n* = 12.

*Distribution*. South-western Western Australia, southern South Australia and south-western Victoria.

*Habitat*. Occurs in both coastal and inland situations, growing in sandy soil around saline depressions, on granite outcrops and in open woodland.

*Phenology & reproductive biology*. Flowering occurs from about September to December.

An average pollen:ovule ratio of 122 was determined for this species (Short 1981a, as *Chrysocoryne drummondii*), a value indicative of self-compatability and high levels of self-pollination.

*Cytology*. Watanabe et al. (1999) recorded *n* = 12 from a population (*P.S. Short 4535*) from Lake King, W.A.

*Selected specimens examined.*

Western Australia: c. 16 km from Brookton along road to Beverley, 21 Nov. 1979, *P.S. Short 1049* (AD, DNA); c. 8.6 km W of Lake Grace, 24 Nov. 1979, *P.S. Short 1085* (AD); Hopetoun airstrip, 10 Nov. 1983, *P.S. Short 2351 & L. Haegi* (AD, MEL, PERTH); c. 1 km W of Lucky Bay, 30 Sep. 1970, *P.G. Wilson 10009* (PERTH).

South Australia: c. 25 km NW of Naracoorte, 18 Nov. 1961, *Hunt 414* (AD); c. 15.2 km from Edilillie along road to Pt Lincoln, 26 Sep. 1978, *P.S. Short 807* (AD).

Victoria: between Apsley and Booroopki, 2 Nov. 1971, *M.E. Phillips* (CANB).

### 8. *Gnephosis tridens* (P.S.Short) P.S.Short

Muelleria 6: 318 (1987). — *Chrysocoryne tridens* P.S. Short, Muelleria 5: 199, figs 9 p.p., 13 (1983). — **Type citation:** "Holotypus … [*P.S.*] *Short 1041*, c. 3.5 km E of Meckering in Mortlock River flats … 20.xi.1979 (AD 98002347). Isotypus: CANB, PERTH." **Holotype:** AD 98002347. **Isotypes:** AD 98121073, CANB 332966, MEL 0108110, PERTH 1043978.

Erect *herb* to 8 cm tall, simple or branched, with scale-like glandular hairs. *Leaves* linear, elliptic or oblanceolate to obovate, 3–8 mm long, 0.5–1 mm wide, with a dense cover of scale-like hairs. *Compound heads* cylindrical to narrowly oblong, 10–63 mm long, 1.5–2 mm diam. *Capitula* 50–250. *Capitulum-subtending bract* 1.7–2.2 mm long; midrib entire. *Capitular* bracts 2, concave, upper margins variably ciliate, the cilia less than c. 0.1 mm long. *Florets* 1; corolla 3- (4-)lobed. *Anthers* 3 (4), each with 8–28 pollen grains. *Cypselas* obovoid, 0.45–0.55 mm long, purplish, papillose. *Pappus* absent. *Chromosome number*: *n* = c. 13. **Fig. 2B.**

*Distribution*. South-western Western Australia, ranging from the Lake Moore region south to salt lakes near Cranbrook and c. as far east as Dundas Rocks.

*Habitat*. Grows in sandy soil and most commonly on the margins of salt lakes but also in shallow depressions associated with granite outcrops.

*Phenology and reproductive biology*. Flowering from about September to November.

An average pollen:ovule ratio of 49 has been determined for this species (Short 1981a, as *Chrysocoryne* sp. C.). Data was obtained from 45 individual plants, with 15 from each of three populations, i.e. *P.S. Short 605*, *614B* and *632*.

*Cytology*. Short (1981b, 1983), using the name *Chrysocoryne tridens*, recorded *n* = c. 13 for a population (*P.S. Short 675*) in saline flats at Wave Rock, W.A.

*Selected specimens examined.*

Western Australia: c. 3.4 km E. of Meckering in Mortlock River, 20 Sep. 1977, *P.S. Short 614B* (AD); southern edge of Lake Moore, 14 Nov. 1977, *P.S. Short 972* (AD); base of Dundas Rocks, 26 Nov. 1979, *P.S. Short 1113* (AD); c. 15.5 km from Borden along Chester Pass road, 3 Nov. 1983, *P.S. Short 2284 & L. Haegi* (AD, MEL, PERTH); salt lake adjacent to Wave Rock, 31 Oct. 1995, *P.S. Short 4530* (MEL).

### *Gnephosis* Cass. s.lat.

*Cyathopappus* F.Muell, Fragm. 2(16): 157 (1861). — **Type:** *C. gnephosioides* F.Muell. [= *Gnephosis arachnoidea* Turcz.]

*Nematopus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 150 (May 1851). — **Type:** *N. effusus* A.Gray [= *Gnephosis arachnoidea* Turcz.].

*Gnephosis* s.lat.: Benth., Fl. Austral. 3: 569 (1867) p.p., excluding *G. burkittii* (= *Lemooria burkittii*), *G. pygmaea* (= *Myriocephalus pygmaeus*), *G. skirrophora* (= *Trichanthodium skirrophorum*), *G. tenuissima* (*Gnephosis* s.str.); O.Hoffm. in Engler & Prantl, Nat. Pflanzenfam. IV(5): 194 (1890) p.p., excluding *Leptotriche* and *Trichanthodium*; P.S.Short in Jessop, Fl. Centr. Austral. 391 (1981); P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1519 (1986), p.p., excluding *G. burkittii* (= *Lemooria burkittii*); R.J.Bayer et al. in Kadereit & C.Jeffrey, Fam. Gen. Vasc. Pl. 8: 266 (2006) p.p., at least excluding *Gnephosis* s.str. as defined above.

?*Crossolepis* Less., Syn. Gen. Compos. 270 (1832). — **Type:** *C. linifolia* Less.

?*Hirnellia* Cass., Bull. Sci. Soc. Philom. Paris 57 (1820). — **Type:** *H. cotuloides* Cass.

[*Leptotriche* auct. non Turcz.; A.Anderb., Opera Bot. 104: 128 (1991); R.J.Bayer et al. in Kadereit & C.Jeffrey, Fam. Gen. Vasc. Pl. 8: 270 (2006), see notes below.]

*Notes*. As with *Calocephalus* s.lat. I believe it likely that the species included here will at some stage be removed from *Gnephosis* and referred to other genera, including some new ones. However, in the meantime I accept them all as members of this genus.

Accounts of species are arranged alphabetically. This is because most may well be distantly related to each other; for the same reason, I have not combined species' descriptions to present a "generic" description. However, some species appear to be very closely related. Thus, morphological features of both *G. gynotricha* and *G. macrocephala* indicate they are closely-related; their most distinctive feature pertains to the arrangement and relative size of the capitular bracts, i.e. the two small outer bracts which surround two inner, subequal bracts, at least the largest of which is much longer than

**Key to species of *Gnephosis* s.lat.**

**1.** Branches and leaves beset with stiff, erect bristles (south-western W.A., probably confined to Monger Drainage System) . . . . . **8. *G. setifera***

**1:** Branches and leaves glabrous or variably hairy but lacking bristles

**2.** Capitula 1-flowered

**3.** Cypselas at least apically, and commonly entirely, enveloped in long, entwined, cottony hairs; major branches prostrate to ascending and with a prominent cottony indumentum; leaves densely cottony (arid areas of N.T., S.A., Qld, N.S.W.) . . . . . **4. *G. eriocarpa***

**3:** Cypselas enveloped in long, straight twin hairs; major branches ascending to erect, mostly sparsely hairy except below the compound heads; leaves glabrous or sparsely hairy (W.A.)

**4.** Leaves straight to somewhat falcate; corolla yellow; pappus possibly absent or a ring to c. 0.2 mm and exceeded by the hairs of the cypsela (W.A., Carnarvon region) . . . . . **5. *G. gynotricha***

**4:** Leaves commonly curved in their upper part and somewhat sigmoid; corolla orange; pappus a small cup c. 0.26–0.6 mm high and somewhat hidden by the hairs of the cypsela (W.A., commonly margins of salt lakes in northern wheat belt and adjoining areas to the north and north-west, absent from the Carnarvon region) . . . . . **6. *G. macrocephala***

**2:** Capitula at least 2-flowered

**5.** Capitula with 2 florets (widespread in semi-arid and arid W.A., N.T., S.A., Qld, N.S.W.) . . . . . **2. *G. arachnoidea***

**5:** Capitula with 4 to c. 36 florets (W.A. only)

**6.** Stem and branches not flexuose, with a cottony indumentum beneath the compound heads . . . . . **3. *G. brevifolia***

**6:** Stem and branches flexuose, glabrous

**7.** Corolla 5-lobed . . . . . **1. *G. acicularis***

**7:** Corolla 3-lobed . . . . . **7. *G. newbeyi***

the outer bracts. Superficially, they closely resemble *Trichanthodium* Sond. & F.Muell. ex Sond., large specimens having a similar habit and there being only a single floret per capitulum. However, they differ from the latter, for example, in having cypselas enveloped in long hairs rather than being covered in a layer of mucilaginous cells. Their fruit morphology suggests a close relationship with *Feldstonia* P.S.Short.

Two other species, *G. acicularis* and *G. newbeyi*, share a number of morphological attributes — including flexuose branches, and bract and fruit morphology — and essentially differ in features indicative of different breeding systems, i.e. large, showy capitular bracts and large 5-lobed corolla in *G. acicularis* compared to smaller, less showy capitular bracts and smaller 3-lobed corollas in *G. newbeyi*. Of all the species here included in *Gnephosis* s.lat., it is perhaps these two which are closest to those included here in *Gnephosis* s.str. Indeed, Anderberg (1991) included *G. acicularis* in *Gnephosis* s.str., a circumscription which is otherwise that accepted here.

I follow Bentham (1867a) in tentatively citing *Crossolepis linifolia* Less. as a possible species of *Gnephosis* s.lat. He (Bentham 1837) had much earlier recorded the problem caused by Lessing's extremely short description of *Crossolepis*. Just what Lessing's name applies to didn't only puzzle Bentham but also Candolle (1838) — who evidently saw no specimen and based his description on Lessing's original — and Gray. Gray (1851a) when describing *G. brevifolia*, recorded that "This, with the following [*G. eriocephala* and *G. pygmaea*] evidently congeneric species, I doubtfully refer to Lessing's genus *Crossolepis*, of which nothing is known beyond the annexed most imperfect character, and that the author places it among his Craspedieæ … Here I should likewise refer these plants, although the glomerule [compound head] and the subtending leaves are so lax … [but] Having usually as many as ten flowers in each capitulum, a naked receptacle, no pappus, and scarious, fimbriate, involucral scales, they must needs be referred to *Crossolepis* until the plant so imperfectly characterized by Lessing shall be further known." (Gray 1851a, pp. 175–176). The fact that Bentham, Candolle and Gray all failed to locate an authentic specimen suggests that one may not exist. My search of the JSTOR Plant Science website in August–September 2012 and specific sites such as the HAL virtual herbarium site (www.botanik.uni-halle.de/herbarium/?lang=en) have also been to no avail.

Flann et al. (2010) cited *Hirnellia cotuloides* Cass. as a synonym of *Angianthus tomentosus* Wendl., providing no evidence for this action, but perhaps following Candolle (1838) who indicated that he had seen a dried specimen. However, no such specimen appears to be in G-DC or the general herbarium, as evidenced by the microfiche of G-DC specimens, an electronic search of holdings, and my own requests on two previous visits to G. I also fail to perceive any gross resemblance of *A. tomentosus* and species of *Cotula*. Thus, I follow Bentham (1867a) in tentatively referring it to *Gnephosis* s.lat., albeit that I do not rule out the possibility that *H. cotuloides* may be another species of *Angianthus*.

Anderberg (1991), following my (Short 1987b) change in circumscription of *Gnephosis*, tentatively suggested that the remaining 12 species could be referred to the genus *Leptotriche* Turcz. He made no new combinations to accommodate them and neither did Bayer et al. (2006), who repeated Anderberg's concepts in recognising *Leptotriche* as a genus of 12 species, overlooking work which had been carried out in the intervening years. Most importantly, *Leptotriche* has been found to be synonymous with *Myriocephalus*

Benth., the sole species now in synonymy under *M. pygmaeus* (A.Gray) P.S.Short (Short 2000). Furthermore, I (Short 1990a) had earlier removed three other species listed by Anderberg — *Gnephosis baracchiana*, *G. exilis* and *G. skirrophora* — to *Trichanthodium* Sond. & F.Muell. ex Sond. The remaining species listed by Anderberg are dealt with in this paper, *G. intonsa* being removed to its own genus, *Notisia*, and remaining names here dealt with under *Gnephosis* s.lat.

**1. *Gnephosis acicularis* Benth.**

Fl. Austral. 3: 572 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 819 (1975). — **Type citation:** "*Drummond, 6th Coll. n.* 201. Of this I have seen a considerable number of specimens ... but unfortunately too young for a full description." **Syntypes:** S.W. Australia, "all too young", 1848, *Drummond 201* (K 000901802); Sw. riv., "all too young", *Drummond* (K 000901803); S.W. Australia, *Drummond 201*, 1848 (K 000901804); Swan River, *Drummond 4: 201*, s.dat. (K 000901805); Swan River, *J. Drummond* (MEL 542230, marked as seen by Bentham); Swan River, *J. Drummond 6*: *201* (A 00008373, collection date given as 1854, ex BM; P 00699000, ex BM in 1914). **Possible isosyntypes:** Swan River, *J. Drummond 4: 201* (MEL 542233, ex herb. Steetz, acquired from Turczaninow in 1851, labelled as "Drummond's 4th colln of 1848"); Swan River, *J. Drummond 201* (G 00223919, received 1848; MEL 542232; PERTH). Swan River, *J. Drummond* (MEL 542231; P 00698995, donated by W.J. Hooker in 1848).

Annual *herb*; stem simple or branching from upper nodes, stem and major branches erect, 8–33 cm long, strongly flexuose, glabrous. *Leaves* alternate, sessile, entire, often subfalcate, linear, 3–47 mm long, 0.1–0.9 mm wide, glabrous, the uppermost leaves usually with a hyaline appendage at the apex. *Compound heads* depressed ovoid to broadly depressed ovoid or broadly obovoid, 4.2–7 mm high, 4–12 mm diam.; general involucre c. ½–⅔ the length of the head but somewhat inconspicuous, of many, brownish, shiny, mainly hyaline bracts with a brown, opaque midrib; general receptacle an expanded, unbranched or shortly branched axis, glabrous. *Capitula* c. 6–50 per compound head. *Capitulum-subtending bracts* 1 to several, resembling capitular bracts and not readily discernible. *Capitular bracts* 15–20 arranged in c. 3 rows, flat to conduplicate, obovate, 2.5–3.7 mm long, 0.6–1 mm wide, mainly hyaline but with an opaque midrib extending c. ⅔ the length of the bract, glabrous or sparsely hairy near the apex of the midrib and the outer bracts with long hairs on the margins, the majority of the bract (claw) narrowly hyaline and gradually to abruptly dilating upwards to a small constriction in the upper part which demarcates a somewhat colourless or an extremely pale yellow, erect and slightly concave terminal lamina which is about the width or wider than the claw. *Florets* 6–14, bisexual. *Corolla* tubular, 5-lobed; tube 1.3–1.6 mm long, outer surface with a few orange glands, inner cells of throat with manifestly undulate margins; vascular tissue reaching or almost reaching the base of the sinus between the lobes, with 1 (2) additional vascular traces formed midway between each of the sinus-reaching traces, these falling well short or almost reaching the base of the sinus. *Stamens* 5; anthers 0.7–0.85mm long, microsporangia 0.53 –0.61 mm long, apical appendages somewhat triangular, 0.17–0.24 mm long; filament collar c. 0.2 mm long, gradually dilating along its length towards the base. *Style* with 2 distinct vascular traces from the base, branches apically truncate, with short sweeping hairs. *Cypselas* obovoid, brown, 0.4–0.5 mm long, c. 0.3 mm diam., smooth; pericarp with 2 vascular bundles; elongate crystals (with 2 long sides and 3 much shorter sides at each end) scattered throughout an internal layer (?testa) visible in cleared fruit; carpopodium annular, whitish. *Pappus* a ciliate ring with 3–5 weak, plumose bristles c. the length of the corolla and detaching with it from the cypsela. *Chromosome number*: $n = 14$.

*Distribution*. Restricted to Western Australia between latitudes c. 29º and 30º S and longitudes c. 115º and 118º E.

*Habitat*. Only known from sandy, saline soils on the edge of salt lakes, e.g. for *L. Haegi 2648* it is recorded that plants grew on a "Sandy rise in samphire flat with other chenopodiaceous shrubs and scattered *Eremophila*".

*Phenology & reproductive biology*. Flowering is recorded from late September to about mid-November.

A pollen:ovule ratio of 1,576 was determined for a single floret removed from *P.S. Short 2182*, a specimen from the margins of Mongers Lake.

*Cytology*. Watanabe et al. (1999) recorded $n = 14$ for a population (*P.S. Short 4425*) near Yellowdine.

*Typification*. As noted above, Drummond used collection numbers but recommenced a fresh series for each of the sets of collections he sent to Europe. Bentham (1863), among others, recorded that it can be difficult to link specimen numbers with any one set of collections. There is also a frequent problem with Drummond material of the same species in that some specimens are numbered and others aren't but, from the appearance of the elements, seem likely to be part of an original single gathering. In the case of *G. acicularis* there is a number of sheets containing specimens attributed to Drummond and, as such, may have type status. However, of them, only four specimens apparently seen by Bentham and labelled in accord with the protologue are definite syntypes, these being labelled as part of the 6th Collection, numbered *Drummond 201*, and housed in K. There is an isosyntype in P and probably one in A.

Other Drummond specimens of this species are, in one way or another, not in accord with the protologue, being unnumbered or numbered as *Drummond 201* but attributed to the 4th, not 6th, collection. For example, in MEL there are four sheets of *G. acicularis* attributed to Drummond. Before mounting, all material now distributed on the sheets was in a common folder and each has a common label noting that this was the case and that "presumably all [are] part of Drummond 4th collection n.

201"; although this may be correct, there are only two sheets with original labels — which simply number them as "*201*", the remaining two are unnumbered. Such discrepancies may simply reflect the "confusion in some of these numbers" referred to by Bentham (1863, p. 10*), and on which he later expounded (Bentham 1867b). Indeed, Bentham (1863, p. 10*) recorded finding numbered Drummond specimens "referred to a wrong series". However, they probably should not be assumed to be isosyntypes of the name *G. acicularis* and I refer to them as having possible type status.

From what is recorded of Drummond's travels and the known distribution of the species it is possible that *G. acicularis* may have been gathered during expeditions to acquire material for both the 4th and 6th collections. If this did happen, the likelihood of both being independently labelled as *201* is low, supporting the notion that all material of *G. acicularis* collected by Drummond and bearing this number is actually part of the one gathering. Conversely, perhaps Drummond — who maintained a herbarium — having collected this species for the 4th set of specimens, deliberately applied the same number in the 6th set of collections after realising that he had recollected the species.

I also note that there are label discrepancies in dates of collection for *Drummond 201*, be they for the 4th or the 6th collection. Thus, Gray (April 1851a, p. 150) cited *Drummond 201* as being collected in 1848, as did Joachim Steetz who recorded "Collect. N.iv. Anni 1848 No. 201" on MEL 542233, but Erickson (1969) did not record a major set of Drummond's collections as having been gathered in that year and George (2009) noted that the 4th collection was made in 1844–47. Presumably the date of 1854 recorded for P 00699000 (*Drummond 6: 201*) is the date of receipt of the specimen, the 6th collection being compiled in 1850–51 (George 2009).

*Notes*. As of 6 July 2012 there is a specimen, *P.S. Short 4439*, on AVH which is referred to this species. It was collected in 1995 prior to my leaving MEL in 1996. I have not seen it since, except for a small, temporary spirit collection gathered for the determination of pollen grain numbers. On examining it I realised that it is not of this species but perhaps referable to, or having affinities with, polymorphic *G. tenuissima* Cass.; the pappus bristles are unusually well-developed, being about the length of the corolla tube and highly and long-dissected.

Cypselas from *L. Haegi 2648*, which was collected in 1983, failed to release mucilage in 2012, after they were soaked in water for three days.

*Selected specimens examined.*

Western Australia: 8 km W of Winchester, 17 Nov. 1975, *Chapman* (PERTH); 93.5 km N of Cleary, 13 Nov. 1983, *L. Haegi 2648* (AD, MEL, PERTH); 54.5 km from Nugadong along road to Bunyidi, 19 Nov. 1979, *P.S. Short 1015* (AD); 21 km N of Wongan Hills, 20 Nov. 1979, *P.S. Short 1032* (AD); Mongers Lake, 23 Oct. 1983, *P.S. Short 2182* (MEL, PERTH).

**2. *Gnephosis arachnoidea* Turcz.**

Bull. Soc. Imp. Naturalistes Moscou 24(1): 189 (March 1851), basionym; Grieve & Blackall, How Know W. Austral. Wildfl. 818 (1975); P.S.Short in Jessop & Toelken, Fl. S. Austral. 1520 (1986); E.A.Brown in G.J.Harden, Fl. New South Wales 3: 257 (1992). — **Type citation:** "*Drum. coll. III. n. 120.*" **Syntypes:** *J. Drummond 3*: *120* (?KW n.v.; P 00699001, ex herb. Schultz-Bip., partly labelled in Turczaninow's hand; MEL 542188, ex herb. Steetz). **Isosyntypes:** *J. Drummond 120* (GH 00008374, ex herb. Klatt; K 000899487, dated 1845, ex herb. Benth.; MEL 542186; NSW, ex BM, received 1915; P 00715967, ex BM, received 1914; PERTH, ex K, ex TCD; PERTH, ex MEL). **Probable isosyntypes:** *J. Drummond* (K 000899488, ex herb. Hook.; MEL 542187; MEL 542189; MEL 542190, ex herb. Sonder; P 00715955, ex herb. E. Cosson, ex MEL).

*Nematopus effusus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 150 (May 1851). — **Type citation:** "Swan River, *Drummond*." **Holotype:** *J. Drummond* (K 000899488, ex herb. Hook., seemingly annotated by Gray). **Isotypes:** *J. Drummond* (MEL 542187; MEL 542189; MEL 542190, ex herb. Sonder; P 00715955, ex herb. E. Cosson, ex MEL). **Probable isotypes:** *J. Drummond 120* (GH: 00008374, ex herb. Klatt; K 000899487, dated 1845, ex herb. Benth., not annotated by Gray; MEL 542186; NSW, ex BM, received 1915; MEL 542188, ex herb. Steetz; P 00715967, ex BM, received 1914; P 00699001, ex herb. Schultz-Bip.; PERTH, ex K, ex TCD; PERTH, ex MEL).

*Cephalosorus leptocladus* F.Muell., Fragm. 3: 158 (1863). — *Gnephosis leptoclada* (F.Muell.) Benth., Fl. Austral. 3: 571 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 818 (1975). — **Type citation:** "In locis lapidosis flumen Murchison versus. Oldfield." Type not seen.

*Cyathopappus gnephosioides* F.Muell., Fragm. 2: 158 (1861), as "*gnephosoides*". — *Cephalosorus gnephosoides* F.Muell., loc. cit., nom. illeg., pro syn. (being a name on specimens). — *Gnephosis cyathopappa* Benth., Fl. Austral. 3: 571 (1867); F.M.Bailey, Compr. Cat. Queensland Pl. 268 (1913); J.M.Black, Fl. S. Austral. 1st ed. 646 (1929), nom. illeg. (The specific epithet *gnephosioides* was available, Art. 63). — *Gnephosis gnephosoides* (F.Muell.) Druce, Bot. Exch. Club Soc. Brit. Isles 4: 624 (1917). — *Gnephosis gnephosoides* (F.Muell.) Domin, Mem. Soc. Roy. Sci. Boheme 2: 121 (1923); J.M.Black, Fl. S. Austral. 2nd ed. 926 (1957). — **Type citation:** "Tam in locis depressis, quam in collibus arenosis secundum Darling flumen. Dr. Beckler." **Lectotype (here designated):** near R. Darling, 1860, *V.E. Exp. Dr. Beckler* (MEL 542185). **Possible isolectotypes or remaining syntypes:** near R. Darling, 31 Oct. 1860, *Vic. Exped.* (K 000899486); dry lake near Menindie [sic], Bambamero [= Lake Pamamaroo], 31 Oct. 1860, *Vict. Exped.* (MEL 542184, seen by Bentham); dry lake near Mennindie [sic], *Vict. Expl. Exped.* (NSW 138928, ex MEL as per attached "Phytologic Museum of Melbourne" label).

*Nematopus foliatus* Sond., Linnaea 25: 486 (1853). — *Gnephosis arachnoidea* var. *foliata* (Sond.) Benth., Fl. Austral. 3: 572 (1867). — *Gnephosis foliata* (Sond.) H.Eichler, Taxon 12: 295 (1963); Grieve & Blackall, How Know W. Austral. Wildfl. 818 (1975); P.S.Short in Jessop, Fl. Centr. Austral. 389 (1981); G.M.Cunningham et al., Pl. W. New South Wales 710 (1981); S.W.L.Jacobs & J.Pickard (1981), Pl. N.S.W. 78; E.A.Brown in G.J.

Harden, Fl. New South Wales 3: 257 (1992). — **Type citation:** "Cudnaka." **Lectotype (here designated):** Cudnaka, 1851, *F. Mueller* (MEL 542182, ex herb. Sonder, with note in Mueller's hand that it was sent to Sonder in 1852, specimen seen by Bentham). **Isolectotype:** Cudnaka, *F. Mueller* (MEL 542183, ex herb. Sonder).

Annual, erect, usually much-branched *herb*, c. 5–30 cm tall, indumentum of cottony hairs prominent in some plants but commonly sparse. *Leaves* lanceolate or linear, 4–34 mm long, 0.5–4 mm wide, the midrib usually prominent on the lower surface, glabrous or with a sparse to dense cottony indumentum, small spherical glandular hairs often present. *Compound heads* depressed-ovoid to broadly depressed-ovoid, 4–10 mm high, 5–12 mm diam.; bracts subtending compound head forming a general involucre which at anthesis are c. ⅓–½ the length of the head, consisting of numerous, leaf-like cottony bracts, the inner-most with yellow, hyaline apices; general receptacle somewhat rounded, with short but distinct minor receptacles, glabrous. *Capitula* c. 50–300; generally held in subgroups of 4 or 5 within the compound head. *Capitular bracts* c. 6–11, in 2 or 3 rows, narrowly oblong, narrowly elliptic or oblanceolate, 1.85–2.5 mm long, 0.4–0.7 mm wide, flat to concave, primarily hyaline but with an opaque midrib extending c. 1/2–5/6 the length of the bract, externally glabrous or sparsely hairy near the apex of the midrib, glandular hairs sometimes present, the lamina with a small constriction in the upper part, upper part yellow. *Florets* 2, bisexual. *Corolla* distinctly tubular in the basal half, yellow or yellow-orange, 5-lobed; lobes all papillate in their lower part; tube 1.2–1.5 mm long; inner epidermal cells of lobes small, straight-walled and tending to be 4- or 5-angled, the walls thickened, those of the throat much larger, elongate, rectangular and their walls not obviously thickened; vascular tissue extending to the base of the lobes; *Stamens* 5; anthers c. 0.87–1.0 mm long, microsporangia c. 0.62–0.74 mm long, apical appendages subrhombic, c. 0.25 mm long; filament collar c. 0.13–0.17 mm long, gradually dilating along its length towards the base. *Style* with 2 distinct vascular traces from the base, apically truncate, long-papillate. *Cypselas* obovoid, 0.8–1.2 mm long, 0.4–0.7 mm diam., brownish, papillose, the papillae minute and white-translucent, myxogenic; pericarp with 2 vascular bundles; irregularly-shaped crystals scattered throughout an internal layer visible in cleared fruit; carpopodium c. 0.1 mm long, white. *Pappus* cup-like, 0.3–0.55 mm long, c. ½ to the length of the basal tube of the corolla, apically almost entire or slightly jagged, whitish. *Chromosome number*: $n = 12$.

*Distribution*. Widespread in arid and semiarid regions of Australia (W.A., N.T., S.A., Qld, N.S.W.), from near-coastal W.A. to central N.S.W. and south-western Queensland.

*Habitat*. Grows in sandy to clay soils, which may also be slightly saline, in an array of arid-zone habitats, including chenopod shrubland, open *Acacia*-dominated shrubland, open eucalypt woodland with a dominant understorey of species of *Senna*, and open herb fields.

*Phenology & reproductive biology*. Flowering mainly occurs in September and October with fruit reaching maturity in October/November. About a third of the herbarium specimens seen were collected in August when the compound heads are conspicuous but few, if any, florets have reached anthesis.

Pollen:ovule ratios, ranging from 3,126 to 4,358 ($\bar{x}$ = 3,674; s.d. = 372; s.e. = 96; n = 15) were recorded for 15 capitula from *P.S. Short 454*, a collection gathered c. 18 km south of Carnarvon, W.A.; 4,188 pollen grains were counted in a floret from *E.H. Ising* (AD 97412134), a specimen from Evelyn Downs, S.A.

*Cytology*. Watanabe et al. (1999) recorded $n = 12$ for two W.A. populations, these being from near Mount Magnet (*P.S. Short 4196*) and Leonora (*K. Watanabe 350*).

*Type specimen of Nematopus effusus*. There is only one syntype specimen of which I am aware, this an unnumbered Drummond collection in K. The only specimen in GH is ex herb. Klatt and was not seen by Gray. Thus, the K collection is regarded as the holotype specimen. Contrary to Gray's comment that "there is no trace of a pappus", a cup-like pappus is present in the holotype.

*Lectotypification of Nematopus foliatus*. I have no record of having seen authentic type material of the name *Nematopus foliatus* in any herbarium other than MEL and have here chosen MEL 542182 as the lectotype specimen, with MEL 542183 being an isolectotype. The specimens are not too dissimilar in appearance and are similarly labelled with Mueller's unpublished binomial in which he referred the species to *Skirrhophorus*. The cited location of "Cudnaka" was Mueller's name for Kanyaka (e.g. Grandison 1990).

*Lectotypification of Cyathopappus gnephosioides*. Both MEL specimens of *Cyathopappus gnephosioides* were undoubtedly examined by Mueller prior to publication and, following Willis (1962), there is no reason to doubt that they, and specimens in K and NSW, were collected by Dr H. Beckler during the Victoria Exploring Expedition, with Beckler based in the Menindee region from 16 October 1860 to 26 January 1861. However, although the specimens are not dissimilar, label data is not identical for these specimens and the information in the protologue, in which it is indicated that the species is found in depressed locations between sandhills along the Darling River, can be interpreted as suggesting that more than one collection of the taxon was made. Therefore, as only MEL 542185 is definitely attributed to Beckler, I have chosen it as the lectotype specimen of the name *Cyathopappus gnephosioides*, with the remaining specimens considered to be possible isolectotypes or remaining syntype specimens. When adopting the illegitimate name *Gnephosis cyathopappa* for this species, in which he cited *Cyathopappus gnephosoides*

in synonymy, Bentham examined MEL 542184 as well as the specimen at K, citing "N.S. Wales. Near Menindie, Darling river [sic], Victorian Expedition."

*Type specimen of Cephalosorus leptocladus*. I have not seen any material which can be considered to be a syntype specimen of this name at MEL and nor do I have any record of having seen one at K. Bentham (1867a, p. 571), in *Flora Australiensis* recorded "Stony places, Barrel Well, Murchison [R]iver, *Oldfield*, a single specimen in Herb. F. Mueller, the inflorescence very rotten. When examined in a better state it may prove to be a variety of *G. cyathopappa*." It is on the basis of this statement and Mueller's original description that I regard the name *Cephalosorus leptocladus* to be a taxonomic synonym of *Gnephosis arachnoidea*. The fact that the type specimen was in a poor state when seen by Bentham, and that both it and the label would have been loose in a folder, suggests that it is no longer extant.

*Notes*. Differences in fruit morphology suggests that this species is distinct from *Gnephosis* s.str. but I have refrained from reinstating the name *Nematopus* A.Gray.

Cypselas from *P.S.Short 2069*, which was collected in 1983, released mucilage from their surface papillae when, in 2012, they were soaked in water for 12 hours.

*Selected specimens examined.*

Western Australia: Belele Stn, 20 Oct. 1965, *D.W. Goodall 3193* (PERTH); 8 km S of Buningonia Well, 19 Nov. 1978, *G.J. Keighery 1965* (CANB, KPBG, PERTH); Rocky Pool, Gascoyne Junction, 15 Oct. 1983, *P.S. Short 2069* (MEL, PERTH).

Northern Territory: 0.5 km W. of Ayers Rock, 30 Sep. 1979, *R.W. Johnson 3376* (BRI, DNA); Tobermorey Stn, Toko Range, 11 Oct. 1995, *P.K. Latz 14628* (DNA, MEL n.v.); 7.5 km SE of Greentree Dam, Hamilton Downs Stn, 18 Oct. 1988, *D.J. Nelson 2688* (DNA).

South Australia: Nilpinna Stn, 10 Oct. 1968, *B. Andrews* (AD 96919216); Watts Bank, Nilpinna Stn, 21 Oct. 1978, *F. Badman 154* (AD, MEL); Coondambo Stn, 25 Oct. 1980, *B. Lay 1217* (AD).

Queensland: Gilruth Plains, 17 Oct. 1948, *A.J. Callender G815* (CANB).

New South Wales: 113 km W. of Wanaaring on Milparinka road, 7 Nov. 1971, *D.F. Blaxell 610* (NSW); 5 km SW of Brewarrina, 3 Nov. 1978, *J. Thompson 2967* (NSW); 45 km from White Cliffs, 22 Nov. 1978, *A. Tyrell 312* (CBG).

### 3. *Gnephosis brevifolia* (A.Gray) Benth.

Fl. Austral. 3: 572 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 819 (1975). — *Crossolepis brevifolia* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 175 (June 1851). — **Type citation:** "S.W. Australia. *Drummond*, 1850." **Lectotype (here designated):** *J. Drummond 5: 61* (K 000901808, labelled "Crossolepis? brevifolia n. sp." in Gray's hand and with pencilled illustrations on sheet, dated 1850, ex herb. Hook.). **Isolectotypes:** *J. Drummond 5: 61* (G 00223918; K 000901809, undated, labelled as "61, suppl. to 5th colln", ex herb. Benth.; KW; MEL 542235; NSW, ex BM, received 20 Jan. 1915, but labelled as "no. 61 of 5th colln suppl. 1849"; P 00715962, ex BM; PERTH, ex K, ex TCD).

*Myriocephalus cotuloides* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 73 (Aug.–Oct. 1851). — **Type citation:** "*Drum. V. n. 61.*" **Holotype:** *J. Drummond 5: 61* (KW). **Isotypes:** *J. Drummond 5: 61* (G 00223918; K 000901808; K 000901809; KW; MEL 542235; NSW, ex BM, received 20 Jan. 1915, labelled as "no. 61 of 5th colln suppl. 1849"; P 00715962, ex BM; PERTH, ex K, ex TCD).

*Crossolepis eriocephala* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 176 (June 1851). — *Gnephosis eriocephala* (A.Gray) Benth., Fl. Austral. 3: 573 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 819 (1975). — **Type citation:** "South-western Australia. *Drummond*, 1850." **Syntypes:** *J. Drummond 5: 62* (K 000901811, labelled "Swan River, *Drummond 62, suppl. 5th colln*", ex herb. Benth.; K 000901810, labelled "*Drummond 62*, S.W. Australia, 1850", with "Crossolepis? eriocephala n. sp." in Gray's hand, with pencilled illustrations on sheet, ex herb. Hook.). **Isosyntypes:** *J. Drummond 5: 62* (G 00223917; GH 00006315, ex herb. Klatt, as "Ser. 5, suppl. 62"; KW; ?CW n.v.; MEL 542198, ex herb. Steetz; MEL 542199; NSW, ex BM, received 20 Jan. 1915, labelled as "no. 62 of 5th colln suppl. 1849"; P 00715961, ex BM; PERTH, ex K, ex TCD; PERTH, ex MEL).

*Myriocephalus villosissimus* Turcz., Bull. Soc. Imp. Naturalistes Moscou 24(2): 74 (Aug.–Oct. 1851). — **Type citation:** "*Drum. V. n. 62.*" **Syntypes:** *J. Drummond 5: 62* (KW; MEL 542198, ex herb. Steetz, received by Steetz from Turczaninow in 1852). **Isosyntype or possible syntype:** G 00223917, PERTH (ex MEL, a single element which may have been removed from the Steetz sheet). **Isosyntypes:** GH 00006315, ex herb. Klatt, as "Ser. 5, Suppl. 62"; K 000901810; K 000901811; MEL 542199; NSW, ex BM, received 20 Jan. 1915, labelled "no. 62 of 5th colln suppl. 1849"; P 00715961, ex BM; PERTH, ex K, ex TCD.

*Gnephosis* sp. Norseman (*K.R. Newbey 8096*) WA Herbarium, as per florabase.dpaw.wa.gov.au/search/current/17721 [accessed 7 May 2015] and biodiversity.org.au/nsl/services/apc-format/display/237272?product=apc [accessed 9 July 2015].

Annual *herb*; stem rarely simple, usually with major branching from basal and near-basal nodes; major branches mostly ascending to erect, sometimes decumbent, 3–20 cm long, with or without minor branching, brown or reddish brown, mostly glabrous except for scattered, shortly-stalked and somewhat rigid glandular hairs less than c. 0.05 mm long and with a cottony indumentum of eglandular hairs beneath the compound heads. *Leaves* sessile, entire, narrowly elliptic, lanceolate, oblanceolate or linear, 3–18 mm long, 0.3–1.5 mm wide, alternate, scattered, may be very slightly succulent, mostly glabrous except for short glandular hairs as on branches but uppermost leaves with some eglandular, white cottony hairs, apically barely and bluntly mucronate. *Compound heads* usually spheroidal to obloid or somewhat broadly depressed ovoid or broadly obovoid, c. 4–9 mm long, 4–10 mm diam., usually distinctly solitary on the end of a branch but sometimes the lateral minor axes are short and up to c. 10 compound heads are held in a loose spike-like arrangement (e.g. *P.S. Short 2016* and *B.H. Smith 505*); general involucre barely developed but several

herbaceous outer bracts and capitulum-subtending bracts together making it conspicuous, the bracts sparsely to densely cottony on their outer surface and glabrous on the inner; *general receptacle* branched, scattered and very shortly stalked glandular hairs and sometimes a few cottony hairs present, each branch appearing to terminate in a single capitulum. *Capitula* (3–) 14–c. 30 per compound head, each capitulum appearing to be subtended by a single, outer, mainly foliaceous bract but 1 or 2 smaller foliaceous ones may be present; at least the largest of these oblanceolate or distinctly spathulate and about the length of the capitular bracts and all such bracts tending to be manifestly cottony on the outer surface but glabrous on the inner. *Capitular bracts* c. 8–11, in 2 rows, not differentiated into a distinct claw and terminal lamina and mainly hyaline except for a midrib extending for c. 1/3–4/5 the length of the bract, ovate to somewhat elliptic or sometimes almost oblanceolate, 2.5–3 mm long, 0.5–1.3 mm wide (excluding hairs), margins with very long and often somewhat tangled hairs for part to most of their length, long and tangled hairs also commonly extending from the outer surface of at least the outermost bracts and these often forming a prominent cottony indumentum, inner surfaces glabrous. *Partial receptacle* hemispherical, glabrous, the whitish bases of the pedicels distinctly scattered over the surface. *Florets* (6–) 12–36, bisexual. *Corolla* 5-lobed and mostly only the lobes exceeding the bracts at anthesis; tube c. 1.4–1.8 mm long, outer surface with scattered multicellular glandular hairs and tending to be somewhat sticky, some cottony hairs may also be present; lobes with slightly thickened margins, papillate (but not distinctly so) at the base of 3 or sometimes 4 lobes; inner epidermal cells of lobes elongate, rectangular with slightly undulate walls, those of the throat somewhat similar, the cells not in distinct rows; vascular tissue almost extending to the base of the lobes. *Stamens* 5; anthers c. 0.72–0.82 mm long, prominently caudate; microsporangia c. 0.52–0.63 mm long; apical appendages triangular, c. 0.17–0.21 mm long; filament collar more or less straight in outline but slightly dilated towards the base. *Style* with 2 distinct vascular traces from the base, nectary small, branches truncate, c. 0.5 mm long, apices longish papillate. *Cypselas* obconic, 0.26–0.35 mm long, 0.2–0.28 mm diam., dark pink, pinkish brown or pale brown, glabrous, on wetting a thin mucilaginous layer formed over the fruit; fruit not sectioned but pericarp appearing to be thin; cleared fruit display a crystalline layer extending around the cypsela, this either in the pericarp or the testa, crystals somewhat oblong; vascular bundles in pericarp 2; carpopodium whitish, c. 0.02–0.04 mm long, often falling from the fruit. *Pappus* absent. *Chromosome number*: $n = 12$.

*Distribution*. Endemic to arid and semi-arid regions of Western Australia, from about the Pilbara region south to about Norseman and Parker Range.

*Habitat*. Found in an array of arid and semi-arid habitats, including chenopod steppe on slightly saline clay or clay loam with species of *Atriplex* and *Tecticornia*; mixed *Acacia* shrubland on red sandy soil; rocky outcrops with shrubs of *Acacia* and *Eremophila*; and in sand or sandy loam on the upper margins of salt lakes.

*Phenology & reproductive biology*. Flowering late August to October, with seed set from about late October to November.

Pollen:ovule ratios ranging from 1,803 to 1,998 ($\bar{x}$ = 1,880; s.d. = 67; s.e. = 34; n = 5) were determined for five florets from *P.S. Short 1567*, collected c. 60 km towards Gascoyne Junction from the North West Coastal Highway.

*Cytology*. Watanabe et al. (1999) recorded $n = 12$ for a population (*P.S. Short 4243*) near Kumarina, W.A.

*Notes*. The corolla tube in most specimens lack cottony hairs on their outer surface but a few collections from the more northern part of the range, such as *P.S. Short 1570*, have them; otherwise they appear to sit within *G. brevifolia*.

The number of capitula in a compound head may vary greatly within and between plants of the one population, e.g. from as few as 6 to 30 in *N.H.Speck 1492*, this in turn affecting the shape of the inflorescence.

In May 2015, subsequent to completing the above description and returning loans upon which the description was based, I examined specimens referred in PERTH to the phrase-name taxon *Gnephosis* sp. Norseman (*K.R. Newbey 8096*) WA Herbarium, including *K.R. Newbey 8096*. They fit within my circumscription of *G. brevifolia*, of which I admit to some uncertainty, but suggest that much of the variation between specimens is a reflection of the harshness, or otherwise, of the environment in which they have grown.

Although lacking various features such as the scale-like hairs and large capitulum-subtending bracts of *Gnephosis tenuissima* the closest relationships of this species may well be with it and/or *G. cassiniana*, with the latter — like *G. brevifolia* — also lacking scale-like hairs (Short 1990c). On the other hand, on morphological grounds a close relationship with the species of *Eriochlamys* is evident; as with them, it lacks a pappus, has thin-walled fruit with a basal, annular carpopodium, and a similar arrangement and morphology of capitular bracts. Furthermore, the corolla tube in the species of *Eriochlamys* (Walsh 2007) also have scattered glands and cottony hair, the feature noted above as occurring in some specimens here referred to *G. brevifolia*. I've independently arrived at this conclusion and note that it is consistent with the result of Anderberg's (1991, fig. 13) analyses of morphological and anatomical characters of the Gnaphalieae, in which *Eriochlamys* is in a clade containing *Gnephosis* s.str. (plus *G. acicularis*) and the monotypic *Hyalochlamys*. (Analyses of nuclear and chloroplast sequences by Bayer et al., 2002, showed *Eriochlamys* to be well-removed from *Gnephosis*, but

the species used in their analyses were *G. arachnoidea*, a species perhaps generically distinct from *Gnephosis* s.str., and *G. intonsa*, here placed in monotypic *Notisia*.)

*Selected specimens examined.*

Western Australia: Between Minderoo and Globe Hill, Ashburton River, 29 Sep. 1905, *A. Morrison* (K, probably also PERTH but only dated Sep. 1905); c. 73 km from the North West Coastal Hwy along the Gascoyne Junction road, 26 Aug. 1982, *P.S. Short 1570* (AD, MEL, PERTH); ¼ mile north of Mellenbye on Morawa to Yalgoo road, 26 Oct. 1984, *B.H. Smith 505* (MEL, PERTH); 35.5 miles east of Wiluna, 25 Sep. 1958, *N.H. Speck 1492* (AD, CANB).

**4. *Gnephosis eriocarpa* (F.Muell.) Benth.**

Fl. Austral. 3: 570 (1867); J.M.Black, Fl. S. Austral. 1st ed. 647 (1929), 2nd ed. 926 (1957); G.M.Cunningham et al., Pl. W. New South Wales 710 (1982); P.S.Short in Jessop, Fl. Centr. Austral. 389 (1981); P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1520 (1986); E.A. Brown in G.J.Harden, Fl. New South Wales 3: 257 (1992). — *Skirrhophorus eriocarpus* F.Muell., Fragm. 3: 156 (1863) ("*Skirrophorus*"). — **Type citation:** "Inter montes Stokes Range et sinum Cooper's Creek legit dr. Wheeler." **Holotype:** between Stokes Range & Coopers Creek, [1861,] *Dr* [*W.F.*] *Wheeler* (MEL 542234).

Annual *herb*; major branches c. 5–25 cm long, usually developing branchlets from upper nodes, with a prominent indumentum of fine, cottony, eglandular hairs. *Leaves* alternate, sessile, entire, held erect, elliptic to narrowly elliptic or more or less linear or obovate to lanceolate, 9–45 mm long, 1.5–9 mm wide, densely cottony. *Compound heads* obloid to spheroid or broadly depressed ovoid to very broadly ovoid, 5–12 mm long, 5.5–13 mm diam.; general involucre conspicuous, c. ⅓–½ the length of the compound heads, consisting of a few leaf-like, woolly outer bracts and a few inner bracts which grade into the capitular bracts; general receptacle a slightly expanded axis. *Capitula* c. 15–80 per compound head, particularly in mature heads several capitula appearing together as slightly discrete groups within the compound head. *Capitular bracts* c. 6–8, obovate, 3–4.2 mm long, 0.65–1.3 mm wide, all bracts mostly flat and with a usually distinct claw and terminal lamina, hyaline except for a yellow-green, opaque midrib extending c. 4/5 or more the length of the claw; claw with wide hyaline margins at least in the upper part but for much of the claw margins not hyaline or very narrowly so and dilating towards the apex of the claw, margins entire but the outer surface with conspicuous cottony, entangling hairs, the hairs mostly about the apex of the claw; lamina ovate to widely ovate, 0.4–1 mm long, 0.3–0.9 mm wide, flat to slightly concave, more narrow to slightly wider than the claw, very pale whitish or pale purple. *Florets* 1, bisexual. *Corolla* 5- or rarely 6-lobed; tube 2.1–2.7 mm long, outer surface glabrous or with globular glands; lobes with slightly thickened margins, with a band c. 0.15–0.2 mm of papillae at the base of all lobes; inner epidermal cells of lobes subrectangular and smaller than the elongate, straight-walled, rectangular cells of the throat; vascular tissue extending or almost extending to the sinus, large papillae sometimes extending along the upper part of the vascular traces. *Stamens* 5; anthers 1.1–1.35 mm long, very prominently cordate, the tails c. 0.25–0.43 mm long; microsporangia c. 0.8–0.93 mm long; apical appendages triangular, c. 0.3–0.44 mm long; filament collar tending to gradually dilate towards the base. *Style* c. 2.3 mm long, with 2 distinct vascular traces from the base; branches c. 0.75 mm long, truncate, with short sweeping hairs. *Cypselas* obconic, 1.1–2.5 mm long, 0.5–0.6 mm diam., at least apically and usually the entire brown fruit enveloped in long, entwined, eglandular, white, cottony, uniseriate, septate hairs; under high magnification (100×) surface cells of the pericarp noticeably elongate and their pattern of thickening giving an appearance of undulating walls, at low magnification (c. 40×) the surface appearing to have numerous, faint longitudinal streaks; cleared fruit display a crystalline layer extending around the cypsela, this either in the pericarp or the testa, crystals 6- or 8-sided but always with 2 sides much longer than the others; vascular bundles in pericarp 2; basally the fruit with a yellowish, plug-like structure (?a modified pedicel) and lacking a distinctly cellular carpopodium. *Pappus* of c. 8–10 scales c. 0.05 mm long with prominently-thickened cell walls, scales terminating in long cottony hairs as on cypselas. *Chromosome number*: unknown.

*Distribution*. An arid zone species found between latitudes c. 23°S and 32°S and between longitudes c. 132°W and c. 144°W, and thus encompassing much of the southern part of the Northern Territory, northern South Australia, south-western Queensland and north-western New South Wales.

*Habitat*. A species found in an array of arid-zone habitats, including open shrubland, the base of sand-dunes, and open herb field dominated by other asteraceous herbs and chenopods. Commonly on sand and sandy loam but also noted in heavier clay soils.

*Phenology & reproductive biology*. Mostly flowering from about late July to late September but with some records as early as May and as late as November.

A pollen:ovule ratio of 4,824 was determined for a single floret from *P.S. Short 3007*, collected between Tibooburra and Wanaaring, N.S.W.

*Typification*. Doctor W.F. Wheeler was surgeon on A.W. Howitt's first relief contingent to search for members of the "Burke & Wills Expedition" and collected specimens representing about 70 species from between Stokes Hill and Coopers Creek in 1861 (e.g. Willis 1962). In regard to this species the only specimen of type status seen by me is that cited above and regarded as the holotype. It is marked as having been seen by Bentham for *Flora Australiensis* and contains an original label in Mueller's hand indicating that he had entertained the idea of naming it after Wheeler. The specimen is poor, consisting of a single branch with two compound heads

and several leaves, plus a fragment bag containing another immature head and some dissected capitula containing unopened florets.

*Notes*. I have examined cleared florets with both immature and near-mature cypselas and am somewhat uncertain as to whether the scale-like objects terminating in long, tangled hairs at the corolla/cypsela interface are part of the pericarp, part of the corolla base, or — as adopted here — because of their location should be deemed to be elements comprising a pappus. As the hairs extending from the scale-like objects appear to be of identical structure to those extending from the pericarp it could be that a pappus should be deemed to be absent, as interpreted by Black (1929).

On a note accompanying a specimen, NSW 138914, collected by the naturalist Dr William McGillivray in August 1921 from Lake Callabonna, S.A., it is recorded that the name "Loompa-loompa" is used by aboriginal people for this species and that small birds use it for nest-making.

*Selected specimens examined.*

Northern Territory: 79 miles SSW of Alice Springs, 2 Sep. 1972, *P.K. Latz 2653* (CANB, MEL, NT); NW Simpson Desert, 30 Sep. 1973, *P.K. Latz 4640* (AD, NT); 1 km north of Henbury Airstrip, Stuart Hwy, 14 Sep. 1978, *J.R. Maconochie* 2431 (BRI, MEL, NT).

South Australia: Happy Thought Well, Blanchewater Crossing, Strzelecki Track, 6 Sep. 1971, *B. Copley 3643* (AD); Stuart Range, c. 65 km E of Coober Pedy, 9 Sep. 1966, *N.N. Donner 1758* (AD); c. 10 km W of Curdimurka, 3 Oct. 1978, *J.Z. Weber 5770* (AD).

Queensland: Poeppel Corner, 24 Sep. 1966, *D.E. Boyland 272A* (BRI, MEL); Currawilla, 11 June 1949, *S.L. Everist 3988* (BRI, CANB); 8 km from Birdsville on new Betoota road, *R.W. Purdie 1137* (BRI).

New South Wales: Tibooburra, 20 Oct. 1949, *E.F. Constable* (NSW10773); Fowlers Gap Stn, 8 km N of Hmsd, 30 Aug. 1973, *G.M. Cunningham & P.L. Milthorpe 1344* (NSW); Byrnedale, Oct. 1971, *W.E. Mulham W512* (NSW).

### 5. *Gnephosis gynotricha* Diels

Bot. Jahrb. Syst. 35: 613, fig. 69 f–j (1905); Grieve & Blackall, How Know W. Austral. Wildfl. 817 (1975). — **Type citation:** "Hab. in distr. Austin litorali pr. Carnarvon in herbosis arenoso-lutosis gregaria flor. m. Aug. (D. 3624)." **Lectotype (here designated):** Carnarvon, Aug. 1901, *L. Diels 3624* (MEL 542201).

*Gnephosis* sp. Billabong (*B. Nordenstam & A. Anderberg 203*), WA Herbarium, as per florabase.dpaw.wa.gov.au/search/current/14349 [accessed 13 May 2015] and biodiversity.org.au/nsl/services/apc-format/display/237271?product=apc [accessed 9 July 2015].

Annual *herb*; major branches ascending to erect, 2–18 (37) cm long, mostly sparsely hairy and tending only to be prominently so beneath the compound heads, the hairs long, white, fine or slightly coarse and often tangled. *Leaves* linear or narrowly elliptic or somewhat falcate, 5–45 mm long, 0.5–2.5 mm wide, glabrous or sparsely hairy, the hairs as on branches, the uppermost leaves usually with a hyaline appendage at the apex. *Compound heads* broadly ellipsoid to ellipsoid or broadly depressed ovoid to ovoid, 4.5–18 mm long, 5–10 mm diam.; general involucre consisting of a few bracts c. 1/5 the length of the heads, inconspicuous, at least in mature heads, the bracts mainly green, opaque but with hyaline margins and apex, sparsely to densely hairy and merging with the capitulum-subtending bracts; receptacle a shortly expanded to cylindrical axis with minor receptacular axes more or less evenly distributed over its surface, glabrous. *Capitula* c. 20–100 per compound head; capitulum-subtending bracts absent or several present, inconspicuous and resembling the outer capitular bracts. *Capitular bracts* 4, in 2 rows. *Outer bracts* 2, concave, of equal size, 1.3–2.2 (2.7) mm long, c. ⅔ the length of the inner bracts, mainly hyaline but with a green, opaque midrib extending most of the length of the bract, glabrous or with a few scattered hairs on the midrib. *Inner bracts* 2, subequal; largest bract 2.6–3.2 mm long, hyaline, midrib not or scarcely developed, concave, and more or less enveloping the floret, glabrous; smaller bract 2.1–2.9 mm long, concave, with a green, opaque midrib extending almost the length of the bract, glabrous or with a few scattered hairs on the midrib. *Florets* 1, tubular, bisexual. *Corolla* 5-lobed; tube 1.5–2mm long; lobes yellow, triangular and somewhat rigid, with slightly thickened margins, all with a narrow (compared to *G. macrocephala*) papillate band (c. 0.1 mm wide) at the base; tube 1–1.2 mm long; inner epidermal cells of lobes much smaller than those of the throat, the walls tending to be straight and not in distinct rows; vascular tissue extending to the base of the lobes, large papillae may occur along this line of tissue. *Stamens* 5; anthers 1.18–1.31 mm long, shortly caudate; microsporangia 0.79–1.0 mm long; apical appendages somewhat triangular, c. 0.3 mm long; filament collar gradually and slightly dilating towards the base, basally not thicker than the filament. *Style* c. 1.7–2.2 mm long, with 2 distinct vascular traces from the base, nectary annular, branches c. 0.55–0.65 mm long, truncate, apices papillate. *Cypselas* obconical or almost so, 0.85–1.05 mm long, 0.6–0.7 mm diam., pubescent, the long straight twin hairs to c. 0.85 mm long and apically minutely bifid; pericarp lacking a layer of sclerenchyma, with a reticulate venation pattern (*P.S. Short 2031*); carpopodium absent. *Pappus* seemingly absent or a ring to c. 0.2 mm high and exceeded by the apical hairs of the cypsela. *Chromosome number*: n = 12.

*Distribution*. Restricted to Western Australia between latitudes c. 24°S and 26°30'S and west of longitude c. 115°W.

*Habitat*. Grows in sand or loam in arid shrubland communities. Collectors' notes include: "in sand ... between shrubs of *Hakea*, *Acacia* & chenopods", "Red-brown loam. Open *Acacia* shrubland", "Red sand-dune dominated by shrubs of *Acacia*", "low chenopod (mainly *Atriplex*) shrubland" and "on red sand ridges among low chenopod shrubs".

*Phenology & reproductive biology*. Flowering is generally recorded from August to September with fruit set in late September and October.

A pollen:ovule ratio of 6,306 was determined for a single floret from *P.S. Short 4338*, collected c. 32 km S of Carnarvon.

*Cytology*. Turner (1970) recorded $n = 12$ for a population (*B.L. Turner 5387*) from near Gascoyne Junction.

*Typification*. Type specimens have not been located at any herbarium other than MEL. The MEL sheet consists of two plants, a packet containing fragments, and an original "Königl. Botanischer Garten und Museum" label, and is here designated as the lectotype specimen of *G. gynotricha*.

Any type material housed in B is believed to have been destroyed (e.g. Orchard 1999). Specimens collected by Diels from Western Australia and now housed in MEL were purchased or donated (e.g. Short 1990d) in the early part of the 20th century.

*Notes*. A unique feature of this species pertains to the fruit. Unlike *G. macrocephala*, and indeed other gnaphalioid species I have examined (Short et al. 1989), this species displays a reticulate venation pattern in the pericarp.

The pappus of this species is minute and at times seemingly absent. In some specimens there is nothing but an almost flat capping on the apex of the fruit, a capping which could possibly, but I suspect erroneously, be interpreted as part of the fruit wall.

The extent and number of large papillae which may occur on the inner surface of the corolla tube and follow the lines of vascular tissue seems to be extremely variable; in one floret viewed under 100× magnification they were common, in another from the same specimen just a few were mostly clustered in the vicinity of a single sinus between two lobes.

Subsequent to completing the above description, in May 2015, I examined two specimens, *B. Nordenstam & A. Anderberg 203* and *P.G. Wilson 12652* referred in PERTH to the phrase-name taxon *Gnephosis* sp. Billabong (*B. Nordenstam & A. Anderberg 203*) WA Herbarium. The specimens, but particularly the *Wilson* specimen, stand out because of their large size, largest plants being more than 30 cm tall, a feature which perhaps reflects growth conditions, i.e. plenty of water and/or growing in shade. Also slightly disconcerting is the fact that the individual capitula within the compound head do not seem to stand out as individual components as much as they do in most specimens but this may be reflective of their stage of flowering. However, plants of both collections lack a pappus — or it is barely developed — and, although some capitular bracts may be slightly larger than in many other specimens, they otherwise tend to fit within my circumscription of *G. gynotricha*. On my determinavit slips I suggest that both are "probably referable" to this species although, particularly in regard to the *Wilson* specimen, I have doubts that this is the case.

*Selected specimens examined.*

Western Australia: 39 km by road NNW of Overlander Roadhouse, 2 Sep. 1977, *E.N.S. Jackson 3117* (AD); c. 1 km N of Boologooro Hmsd, 25 Aug. 1982, *P.S. Short 1550* (AD, CANB, MEL, PERTH); c. 50 km SE of Carnarvon, 27 Aug. 1982, *P.S. Short 1571* (AD, CANB, PERTH); c. 14 km SE of Carnarvon, 12 Oct. 1983, *P.S. Short 2031* (MEL, PERTH); 26 miles E of Gascoyne Junction, 22 Aug. 1965, *B.L. Turner 5387* (KPBG, MEL, PERTH).

### 6. *Gnephosis macrocephala* Turcz.

Bull. Soc. Imp. Naturalistes Moscou 24(1): 190 (March 1851); Benth., Fl. Austral. 3: 570 (1867); Grieve & Blackall, How Know W. Austral. Wildfl. 817 (1975). — **Type citation:** "*Drum. coll. IV. n. 202.*" **Syntypes:** *J. Drummond 4: 202* (?KW n.v., not listed by Marchant 1990; MEL 542197, ex herb. Steetz, with label in Turczaninow's hand). **Isosyntypes:** *J. Drummond 4: 202* (G 00223916; GH 00008375, ex herb. Klatt; K 000899483, ex herb. Benth.; K 000899484; K 000899485; MEL 542196, seen by Bentham; P 00699002, but as "5th colln 202, 1849"; P 00715963, dated 1848; PERTH. **Probable isosyntypes:** Swan River, *J. Drummond* (GH 00004646; K 000899482; MEL 542195; P 00715960, donated W.J. Hooker 1848).

*Cephalosorus gymnocephalus* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 153 (May 1851). — **Type citation:** "Swan River, *Drummond*, 1848." **Lectotype (here designated):** Swan River, *Drummond* (K 000899482, annotated as "*Cephalosorus gymnocephalus* n. gen." by Gray, ex herb. Hook.). **Isolectotypes:** GH 00004646, annotated by Gray; MEL 542195; P 00715960, donated W.J. Hooker 1848. **Probable isolectotypes:** *J. Drummond 4: 202* (G 00223916; GH 00008375, ex herb. Klatt; K 000899483, ex herb. Benth.; K 000899484, ex herb. Hook.; K 000899485, ex herb. Hook.; ?KW n.v., not listed by Marchant (1990); MEL 542196; MEL 542197; P 00699002, but as "5th colln, 202, 1849"; P 00715963, dated 1848; PERTH).

Annual *herb*; major branches ascending to erect, 4–38 cm long, mostly sparsely hairy, the hairs long, white, fine to somewhat coarse and often tangled. *Leaves* linear or lanceolate, somewhat stiff and often curved in the upper half and sometimes the leaf somewhat sigmoid, 5–38 mm long, 0.5–0.8 mm wide, glabrous or sparsely hairy and the hairs as on the branches, the uppermost leaves usually with a hyaline appendage at the apex. *Compound heads* very broadly ovoid to ovoid, sometimes obloid, 5.5–20 mm long, 5.5–14 mm diam.; general involucre consisting of numerous bracts in several rows, c. ¼–⅓ the length of the heads, inconspicuous, at least in mature heads, the bracts mainly green, opaque but with hyaline margins and apex, sparsely to densely hairy and merging with the capitulum-subtending bracts; receptacle a shortly expanded to cylindrical axis with minor receptacular axes more or less evenly distributed over its surface, glabrous. *Capitula* 20–c. 200 per compound head; capitulum-subtending bracts absent or several, inconspicuous and resembling the outer capitular bracts. *Capitular bracts* 4, in 2 rows. *Outer bracts* 2, concave,

of equal size, 2.3–3.5 mm long, 3/4–4/5 the length of the largest inner bract, mainly hyaline but with a green, opaque midrib extending most of the length of the bract, glabrous or with a few scattered hairs on the midrib. *Inner bracts* 2, unequal in length; largest bract 3–4.3 mm long, hyaline, midrib not or scarcely developed, concave, and more or less enveloping the floret, glabrous; smaller bract 2.4–3.6 mm long, concave, with a green, opaque midrib extending almost the length of the bract, glabrous or with a few scattered hairs on the midrib. *Florets* 1, tubular, bisexual. *Corolla* dark yellow or yellow-orange, 5-lobed, tube 1.6–2.8 mm long; lobes with thickened margins, 2–4 lobes with a papillate band c. 0.5–0.6 mm wide in the lower c. ⅓ and extending into the throat; inner epidermal cells of lobes and those of the throat somewhat similar in size and with undulating margins; vascular tissue extending to the base of the lobes, occasional large papillae may be present along the tissue line. *Stamens* 5; anthers 1.48–1.6 mm long, shortly caudate; microsporangia 1.1–1.27 mm long; apical appendages subtriangular to ovate, c. 0.3–0.4 mm long; filament collar straight in outline or slightly dilating, basally not thicker than the filament. *Style* c. 2–3 mm long, with 2 distinct vascular traces from the base, branches c. 0.6–0.7 mm long, apically truncate and papillate. *Cypselas* somewhat obconical, 1–1.3 mm long, 0.55–0.7 mm diam., pubescent, the long straight twin hairs apically minutely bifid, the longest hairs c. 0.6–0.8 mm long; pericarp lacking a layer of sclerenchyma (*L. Haegi 2640*), vascular bundles 2; carpopodium absent. *Pappus* a small cup c. 0.26–0.6 mm high, somewhat hidden by the apical hairs of the cypsela. *Chromosome number*: unknown.

*Distribution*. Restricted to Western Australia between latitudes c. 27ºS and 31ºS, and W of longitude c. 123ºE.

*Habitat*. Commonly found in somewhat saline soil on the margins of salt lakes. Collectors' notes include: "Low lying samphire flats with scattered shrubs of *Lycium australe*, *Dodonaea*, *Atriplex spongiosa* ... reddish-brown sandy loam", "In very sandy loam amongst samphire and *Gunniopsis*" and "[in] travertine gypsum".

*Phenology & reproductive biology*. Flowering is mostly recorded in October and November.

A pollen:ovule ratio of 6,068 was determined for a single floret from *P.S. Short 4394*, a specimen collected c. 12 km from Leonora along the road to Menzies.

*Notes*. This species can be difficult to distinguish from *G. gynotricha*, at least in herbarium specimens. However, in good specimens, and in the field, it is readily distinguishable by the often yellow-orange, not yellow, florets, a generally more robust habit, and the leaves which are frequently curved in their upper part. The pappus is also generally larger in this species than in *G. gynotricha*.

*Selected specimens examined.*

Western Australia: Lake Carey, 7 Oct. 1973, *H. Demarz 4611* (KPBG, PERTH); Lake Austin, 18 Oct. 1980, *H. Demarz 8343* (KPBG, PERTH); c. 76 km N of Bullfinch, 4 Nov. 1983, *L. Haegi 2563* (AD, BRI, CANB, CBG, HO, MEL, NSW, PERTH); 7.5 km N of Latham, 13 Nov. 1983, *L. Haegi 2662* (AD, BRI, CANB, CBG, HO, NSW, MEL, PERTH); c. 7.5 km E of Three Springs, 14 Nov. 1983, *P.S. Short 2392* (AD, CANB, MEL, NSW, PERTH).

### 7. *Gnephosis newbeyi* P.S.Short, *sp. nov.*

**Type:** Western Australia. Western edge of Lake King, 33º 05'S, 119º 31'E, Growing in sand under *Melaleuca* and amongst samphire, 10 Nov. 1983, *P.S. Short 2358 & L. Haegi* (holotype: MEL 1524610; isotypes: AD, PERTH).

Annual *herb*; stem simple or with major branches from upper nodes; branches erect, 3–13 cm long, strongly flexuose, glabrous. *Leaves* alternate, sessile, entire, often subfalcate, linear, 4–15 mm long, 0.1–0.2 mm wide, glabrous, the uppermost leaves usually with a hyaline appendage at the apex. *Compound heads* obloid, depressed ovoid to broadly depressed ovoid or broadly obovoid, 2.5–3.5 mm long, 1.7–4 mm diam.; general involucre c. ½–⅔ the length of the head but not inconspicuous, of many, brownish, shiny, mainly hyaline bracts with a brown, opaque midrib; general receptacle an expanded, unbranched or shortly branched axis, glabrous. *Capitula* 3–8 per compound head. *Capitulum subtending bracts* 1, widely obovate, 1.9–2.1 mm long, 1.5–1.8 mm wide, glabrous, usually readily differentiated from the capitular bracts. *Capitular bracts* c. 15, flat to conduplicate, obovate, 1.5–2 mm long, 0.5–1.1 mm wide, arranged in c. 3 rows, mainly hyaline but with an opaque midrib extending c. ⅓–⅔ the length of the bract and generally with a distinct claw and apical lamina, glabrous or with a few minute glandular hairs on the midrib; claw with hyaline margins throughout their length with the margins gradually dilating towards the lamina *or* in the inner bracts the hyaline margins only in c. the upper half of the claw; lamina somewhat colourless or an extremely pale yellow, erect and slightly concave, about the width or wider than the claw. *Florets* 4–13, tubular, bisexual. *Corolla* 3-lobed; tube c. 0.8 mm long, externally with or without several prominent orange, globular glands and often sticky. *Style* branches truncate, with short sweeping hairs. *Stamens* 3; anthers c. 0.3 mm long. *Cypselas* obovoid, brown, c. 0.45 mm long, c. 0.25 mm diam.; carpopodium annular, whitish. *Pappus* a white ring with usually entire bristle-like elements c. 0.1–0.3 mm long but one or several elements in a ring extending c. ½ to about the length of the corolla may be present. *Chromosome number*: unknown. **Fig. 8.**

*Distribution*. Only known to me from the margins of Lake King and other salt lakes near Pingrup and Peak Charles.

*Habitat*. Plants comprising both the holotype collection and *K. Newbey 7843* were growing in saline sandy soil in a *Melaleuca* zone surrounding a salt lake.

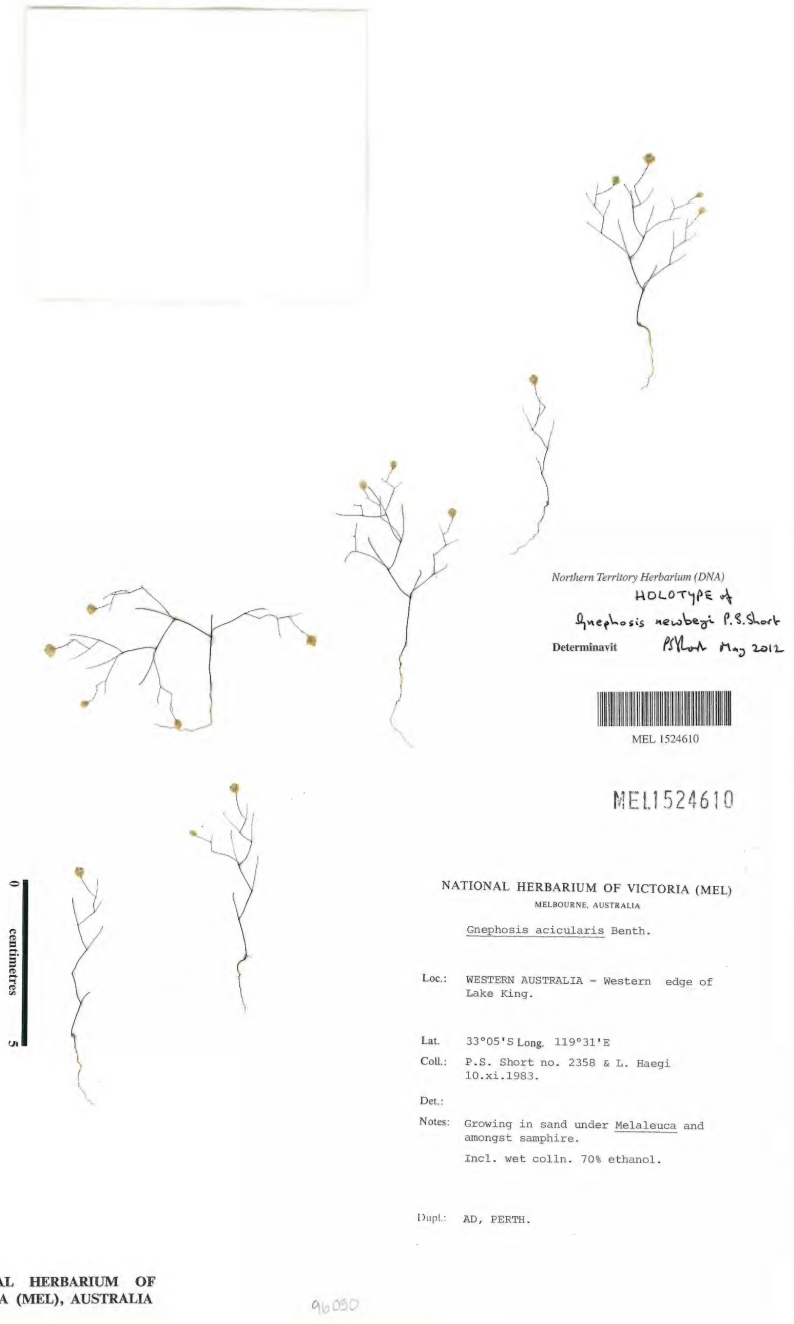


**Fig. 8.** Holotype of ***Gnephosis newbeyi*** (MEL). — *P.S. Short 2358 & L. Haegi.*

*Phenology & reproductive biology*. The only specimens seen were collected in November.

The small capitula, 3-lobed florets with 3 anthers, and small anthers with few pollen grains are indicative of selfing and self-compatiblity.

*Etymology*. The epithet commemorates Ken Newbey (1936–1988), among other things the collector of more than 12,000 plant specimens (Kenneally 1988, Underwood 2011), including the specimen which first drew my attention to the existence of this species.

*Notes*. The species is readily distinguished from *G. acicularis* by its 3-lobed corolla with three stamens, not 5-lobed corolla with five stamens.

The label associated with the type specimen indicates that there is a spirit collection associated with it; this is not the case.

*Additional specimens examined.*

WESTERN AUSTRALIA: W edge of Lake King, 12 Nov. 1978, *R.J. Chinnock 4363* (AD); 3 km E of Peak Charles, 2 Nov. 1980, *K. Newbey 7843* (PERTH); 10 km SW of Pingrup, 23 Nov. 1979, *P.S. Short 1072* (AD).

### 8. *Gnephosis setifera* P.S.Short

Muelleria 7: 244, fig. 2 (1990). — **Type citation:** "Holotypus: Western Australia, c. 7 km S of Bunjil along road to Latham … 16.ix.1986, [*P.S.*] *Short 2955,* [*M.*] *Amerena &* [*B.A.*] Fuhrer (MEL 117004). ISOTYPUS: PERTH."

Prostrate *herb* with branches to c. 5 cm long or sometimes consisting of a single, sessile compound head in a basal rosette of leaves, branches and leaves with scattered, erect bristles. Leaves oblanceolate or spathulate, 3.5–15 mm long, 1.5–2.6 mm wide. *Compound heads* broadly depressed to depressed ovoid, 3–5 mm high, 5–16 mm diam.; bracts subtending compound head forming a conspicuous involucre of leaf-like bracts; general receptacle branching. *Capitula* 10–45. *Capitulum-subtending bract* absent. *Capitular bracts* in 2 or 3 rows; outer bracts 1–4, leaf-like, with bristles and long-flexuose hairs; inner bracts 8–12, in 1 or 2 rows, mostly hyaline, margins long-ciliate, outer surface sometimes with long-flexuose hairs. *Florets* 5–11; corolla 5-lobed; lobes with slightly thick margins, papillate at the base of each lobe; inner epidermal cells of lobes and throat with straight margins; vascular tissue more or less extending to the base of the lobes. *Cypselas* obovoid, 0.44–0.57 mm long, dark pink; pericarp with 2 vascular bundles; carpopodium absent. *Pappus* absent. *Chromosome number*: unknown. **Fig. 2D.**

*Distribution*. Endemic to the margins of salt lakes of the northern wheat belt, W.A., possibly being confined to the Monger River drainage system.

*Habitat*. From sandy, presumably slightly saline, soils. Recorded associates include species of *Atriplex*, *Gunniopsis* and *Tecticornia*.

*Phenology & reproductive biology*. Flowering is recorded for September (as per specimens seen to 1990).

A pollen:ovule ratio of 1,664 (Short 1990c) determined from a single floret suggest cross-pollination but also self-compatibility.

*Notes*.The general vestiture of bristles, prostrate habit, and compound-heads make this one of the most readily identifiable species of Australian gnaphalioid taxa.

*Selected specimens examined.*

WESTERN AUSTRALIA: On the road from Perenjori to White Wells, 1 km E of Mongers Lake, 19 Sep. 1987, *G. Bergqvist* (MEL, PERTH, S); 5 km S of Morawa, 8 Sep. 1995, *P.S. Short 4371* (MEL, PERTH, TI).

### *Leucophyta* R.Br.

Trans. Linn. Soc. London 12: 106 (25 Feb. 1818; as preprint before Sep. 1817); R.Br., J. Phys. Chim. Hist. Nat. Arts 86: 409 (1818); Cass. in Cuvier, Dict. Sci. Nat. 26: 158 (1823); Less., Syn. Gen. Compos. 271 (1832) ("*Brownei*"); DC., Prodr. 6: 152 (1838); R.Br., Verm. Bot. Schr. 2: 546 (1826); Steetz in Lehm., Pl. Preiss. 1: 442 (1845); A.Anderb., Opera Bot. 104: 125 (1991); P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 799, fig. 159c (1999); R.J.Bayer et al. in Kadereit & C.Jeffrey, Fam. Gen. Vasc. Pl. 8: 270 (2006). — **Type:** *Leucophyta brownii* Cass.

*Shrub*, densely branched and cushion-like or somewhat spreading, tomentose. *Leaves* alternate, sessile, entire, tomentose, at least the uppermost usually strongly appressed. *Compound heads* present; general involucre inconspicuous; general receptacle conical, with minor receptacular appendages distributed more or less evenly over its surface, glabrous to sparsely hairy, with glandular hairs. *Capitula* many per compound head. *Capitular bracts* in 2 rows, flat to conduplicate, usually scarious but with an opaque brown to green midrib extending all or most of the length, sometimes the scarious margins absent, never manifestly differentiated into a distinct claw and terminal lamina defined by a constriction, all bracts sparsely to densely hairy at or just below the apex, glandular orange hairs often present on the midrib. *Florets* (1) 2 or 3, tubular, bisexual. *Corolla* 5-lobed; tube with outer surface glabrous; lobes all with thickened margins, c. the lower 2/3 of their inner surface papillate; inner epidermal cells of throat somewhat rectangular and straight-walled; vascular tissue perhaps extending to the sinus, large papillae extending along the upper part of the vascular traces. *Stamens* 5; anthers prominently cordate; apical appendages triangular; filament collar tending to gradually dilate towards the base. *Style* with 2 distinct vascular traces from the base; branches truncate, with short sweeping hairs. *Cypselas* monomorphic, obconic, brown, with scattered multicelled, glandular hairs; pericarp with the outer cells thick-walled, with two vascular bundles; cleared fruit display a crystalline layer extending around the cypsela, this either in the pericarp or the testa, crystals narrowly rectangular or narrowly hexagonal; carpopodium absent. *Pappus* of multiseriate, plumose bristles united at the base, about the length of the corolla tube. *Chromosome number*: $n = 9$.

*Distribution*. Australia.

*Etymology*. Derived from the Greek *leucon*, meaning white, and *phyton*, for plant.

*Notes*. As with *Calocephalus* this genus was first described by Robert Brown (1817) in a paper titled "Observations on the natural family of plants called Compositae …", a paper subsequently translated into French by Cassini, and to which both Brown and Cassini provided additional notes. The original paper was also included in Nees von Esenbeck's "Robert Brown's Vermischte botanische Schriften", to which Lessing referred in his treatment of both *Calocephalus* and *Leucophyta*.

*Leucophyta* is differentiated from other compound-headed gnaphalioid tax in Australia by both its shrubby habit and coastal habitat, the only exception being *Angianthus cunninghamii* which is also a coastal, shrubby species but manifestly differs, among other things, in the structure and arrangement of the capitular bracts, in having papillate cypselas, and in lacking a pappus.

**1. *Leucophyta brownii* Cass.**

in Cuvier, Dict. Sci. Nat. 26: 159 (1823); Less., Syn. Gen. Compos. 271 (1832) ("*Brownei*"); DC., Prodr. 6: 152 (1838); Steetz, Pl. Preiss. 1: 442 (1845); Hook.f., Fl. Tasman. 1: 196 (1860) ("*Brownei*"); P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 799, fig. 159c (1999). — *Calocephalus brownii* (Cass.) F.Muell., Rep. Pl. Babbage's Expedition 13 (1859); F.Muell., Second Gen. Rep. Veg. Colony [Victoria] 12 (1854), nomen nudum; Benth., Fl. Austral. 3: 575 (1867); J.M.Black, Fl. S. Austral. 1st ed. 648 (1929), 2nd ed. 928, fig. 1230 (1957); W.M.Curtis, Stud. Fl. Tasman. 345 (1963); J.H.Willis, Handb. Pl. Victoria 2: 732 (1973); Grieve & Blackall, How Know W. Austral. Wildfl. 821 (1975); P.S.Short in Jessop & Toelken, Fl. S. Austral. 3: 1502A, fig. 681 (1986). — **Type citation:** "Nous avons fait cette description spécifique, et celle des caractères génériques, sur plusieurs échantillons secs qui se trouvent dans l'herbier de M. de Jussieu. Ces échantillons, recueillis sur la côte occidentale de la Nouvelle-Hollande, près le port du Roi George, et sur la côte australe, près le détroit de Bass, nous ont offert quelques différences …" [based this specific description and that of the generic characters on several dry specimens which are found in M. de Jussieu's herbarium. These samples gathered from the western coast of New Holland, near Port King George, and on the southern coast, near Bass Strait ...]. **Lectotype (here designated):** détr. de Bass [Bass Strait], *Anon.* (P 00715976). **Remaining syntypes:** Nouv. holl. port du R. georges [King George Sound], (P 00715983); ile King [King Island] (including P 00715982 and, by my notes, perhaps two other sheets in P; S (S-G-3638, ex P). **Possible remaining syntypes:** Nouv. Hollande, Voyage of Baudin, 1801 (P 00715984). See notes below.

*Leucophyta brownii* var. *candidissima* Steetz in Lehm., Pl. Preiss. 1: 442 (1845); W.R. Elliot & D.L. Jones, Encyc. Austral. Pl. 6: 147 (1993). — **Type citation:** "In clivulis arenosis ad maris litora, haud procul ab oppidulo Freemantle. Exeunte Januario, 1839. Herb. Preiss. No. 31. (Specimina glomeruligera, sed floribus nondum evolutis.) In Nova Hollandia leg. cl. Ferd. Bauer. (V.s. in herbario aulico Vindobonn.)." **Lectotype (here designated):** *J.A.L. Preiss 31* (MEL 543270, ex herb. Steetz). **Isolectotypes:** G 00222881, LD 1052804, MEL 543269, P (3 sheets, one ex herb. Schulz–Bip., one ex herb. Drake, the latter P 00715987).

*Leucophyta brownii* var. *virescens* Steetz in Lehm., Pl. Preiss. 1: 443 (1845). — **Type citation:** "In colliculis arenosis insulae Rottennest, mense Aug. 1839. Herb. Preiss. No. 32. (Specimina florentia). In Nova Hollandia leg. cl. Ferd. Bauer. (V.s. in herb. aulico Vindobonnensi.) In insula van Dieman leg. cl. Gunn. Herb. Gunn. No. 433." **Lectotype (here designated):** *J.A.L. Preiss 32* (MEL 543271, ex herb. Steetz). **Isolectotypes:** S (S-G-3639), P.

*Shrub* to c. 1 m high, often densely branched and cushion-like but sometimes more open and spreading, branches grey-white, white or somewhat silvery-tomentose. *Leaves* narrowly oblong to linear or narrowly elliptic or ovate to lanceolate, 1.5–14 mm long, c. 0.8–1.2 mm wide, white to grey-white tomentose, at least the uppermost ones usually strongly appressed. *Compound heads* broadly depressed ovoid or spheroidal, 6–16 mm long, 7–15 mm diam.; general involucre inconspicuous, of a few leaf–like bracts. *Capitula* 30–110 per compound head. *Capitular bracts* 9–13, in 2 rows, obovate or elliptic, flat to conduplicate, 1.8–3.75 mm long, 0.8–1.7 mm wide. *Florets* (1) 2 or 3. *Corolla* 5-lobed; tube 1.6–2.1 mm long. *Stamens* 5; anthers 1.06–1.35 mm long, very prominently cordate, the thickish tails c. 0.2–0.35 mm long; microsporangia 0.82–0.97 mm long; apical appendages triangular, c. 0.22–0.29 mm long. *Style* c. 2.3–2.35 mm long; branches c. 0.7 mm long. *Cypselas* obconic, 1.2–1.8 mm long, 0.7–1.2 mm diam., brown, with scattered multi-celled, glandular hairs. *Pappus* of 10–13 bristles. *Chromosome number*: $n = 9$. **Fig. 9.**

*Distribution*. Coastline of south-western Western Australia, South Australia, Victoria and Tasmania.

*Habitat*. A coastal plant which occurs on rocky shores, in coastal dunes — where associates may include species such as *Acacia longifolia* (Andrews) Willd., *Apium prostratum* Labill. ex Vent. and *Leucopogon parviflorus* (Andrews) Lindl. — and along the foreshore of many beaches, where it may form a distinct zone, e.g. as at Hardwicke Bay, Yorke Peninsula where I have observed it growing above a zone of *Spinifex sericeus* R.Br.

*Phenology & reproductive biology*. Typically a summer-flowering species.

A pollen:ovule ratio of 4,594 was determined for a single floret from *P.S. Short 1944*, a specimen gathered from Badger Head, Tasmania.

Elliot & Jones (1993) recorded that seed (provenance not provided) germinates without pre-sowing treatment within 10–30 days and that cuttings readily strike from semi-hardwood growth.

*Cytology*. Short (1986b) recorded $n = 9$ for a population (*P.S. Short 301*) from near Port Minlacowie, Yorke Peninsula, S.A.

**Fig. 9. *Leucophyta brownii***, near Port Minlacowie, S.A. (unvouchered). — Photo: P.S. Short.

*Typification*. Unfortunately, there is a number of specimens of *L. brownii* held in P to which I have added incorrect determinavit slips regarding their type status. This, in part, is because of my mistake in regards to what constitutes a type of a genus (Art. 10), but also because of a misreading of the protologue of *L. brownii*. In the former category there are a number of collections gathered by Robert Brown which, contrary to my determinavits, have no type status as, although Brown named the genus the naming of a species was left to Cassini. These are, or at least include, specimens now numbered as P 00715971, P 00715974 and P 00715975, the numbers being absent when I examined specimens in 1991.

In regards to syntype specimens of *L. brownii*, I initially believed the wording in the protologue to have included any specimens collected during the Baudin expedition from the southern coast of Australia. However, the wording (see above) actually excludes specimens from Kangaroo Island (P 00715979, P 00715980, P 00715981, P 00715985, P 00715986) and St Francis Island (P 00715977, P 00715978), both islands being off the coast of South Australia and surely not "near" Bass Strait. With those specimens excluded I have opted to choose a specimen (P 00715976) clearly labelled as coming from Bass Strait as the lectotype specimen. This specimen has a printed label stating "Nouvelle Hollande, Côte méridionale. Voyage aux Terres-Australes. Capitaine Baudin 1801." while a further label attached to it has the handwritten name "Leucophyta Brownei Cass." and, in the same hand, the locality is given as "détr. de Bass" (i.e. Bass Strait). Although I have some doubts, the annotation "détr. de Bass" appears to be in the hand of Antoine Laurent de Jussieu (1748–1836), which is consistent with the statement in the protologue that the specimens seen by Cassini were in Jussieu's herbarium. Although no specimens appear to have been annotated by Cassini I have no reason to doubt that the specimen chosen as the lectotype was examined by him. A King George Sound specimen and several from King Island — a principal stopping point for the Baudin expedition and on the western edge of Bass Strait — are regarded as remaining syntype specimens.

Labels suggesting that the lectotype and some other specimens attributed to the Baudin Expedition were gathered in 1801 are incorrect; they must have been collected from the southern Australian coastline in 1802 and 1803 (e.g. Brosse 1983, Cornell 1974).

*Notes*. I have no doubt that habit and leaf size in these plants is modified by environmental factors. Sand-laden winds would no doubt efficiently prune shoots and maintain a compact cushion-like habit while plants largely buried in sand may develop comparatively longer branchlets than their wind-exposed neighbours. However, Cassini (1823), Steetz (1845) and Bentham (1867a) all alluded to the variability of this species, with the latter noting that "the Western specimens are generally more vigorous than the others, with longer leaves and larger heads" (Bentham 1867a, p. 574). Elliot & Jones (1982, p. 433) also noted a "more vigorous and less compact form in cultivation [which] originated from near Cape Le Grand, W.A.". I have only observed the species twice in Western Australia (as represented by *P.S. Short 3890 & 3892*) and at few localities in the eastern States. However, I concur with the aforementioned authors that the mostly spreading, longer-leaved specimens from Western Australia also have less rigid branches and the entire shrubs tend to sprawl or at least be comparatively open rather than having the cushion-like habit (which is associated with comparatively rigid, intricate branchlets) and generally shorter and more appressed leaves common in specimens from the eastern States. Furthermore, Tony Rodd (in litt. 1987) noted that specimens gathered near Cape Leeuwin (W.A.) and cultivated in Sydney maintain their distinctive habit and leaf-size.

Thus, there are grounds for formally recognising infraspecific taxa, as did Steetz (1845) when recognising var. *candidissima* Steetz and var. *virescens* Steetz, and I have deliberately lectotypified both names with specimens collected from W.A. As the specimens are part of the Steetz herbarium this is not only in accordance with recommendations in the *Code*, but leaves the names free for application should it be deemed useful to formally apply either name to western material, the lectotype specimen of *L. brownii* coming from Bass Strait and being representative of the entity forming a compact shrub and having short and mostly appressed leaves. Having examined the lectotype specimens of both var. *candidissima* and var. *virescens* I also believe that they are representative of the same entity and if one is to be adopted, it should be the name var. *candidissima*, the lectotype of which best represents both the white-silvery appearance and the robust nature of the majority of the W.A. specimens I've examined. Elliot & Jones (1993) followed my advice in doing just that.

Although there is considerable evidence to justify the recognition of var. *candidissima* — which at least

extends to the W.A./S.A. border as evidenced by a collection from the Eucla area collected by J.D. Batt in 1887 (MEL84909) — I am not totally convinced that this is warranted. This is partly because I have viewed few specimens from South Australia, not having examined the many specimens in AD, but also because a few specimens do not support the recognition of two taxa (albeit that I believe that the varietal level allows for some morphological intermediates). For example, *R.D. Royce 6166*, a specimen from Wilson Island, Recherche Archipelago has comparatively short leaves and probably a more cushion-like habit than that normally associated with W.A. specimens while, in Victoria, a specimen (NSW 138963), probably collected by Carl Walter in 1892 from Portland, exhibits longs stems and spreading, long (but narrow) leaves more in keeping with specimens from W.A. I also note that a specimen *M.E. Phillips 122* (CBG) cultivated from cuttings originally obtained from Venus Bay, Victoria, displays intricate branching at the base but much longer new growth more typical of the W.A. variant; the uppermost leaves on the longest shoot also displays longish somewhat appressed leaves similar to those on the lectotype of the var. *candidissima*. For these reasons I have here opted not to recognise varietal levels within this taxon; others may disagree.

*Selected specimens examined.*

Western Australia: Point Ann, Fitzgerald River Res., 16 Mar. 1972, *A.S. George 11280* (PERTH); Wilson Is., Recherche Archipelago, 1 Feb. 1960, *R.D. Royce 6166* (PERTH).

South Australia: Policeman's Point, Coorong, 26 Dec. 1967, *C.E. Chadwick* (NSW 138989); Nora Creina Settlement, 15 Feb. 1987, *P. Gibbons 659* (AD, MEL); creek mouth, Second Valley, 4 Feb. 1965, *D.E. Symon 3217* (AD, CANB).

Victoria: Port Fairy, 21 Jan. 1988, *M.G. Corrick 570* (MEL); The Lakes Coastal Park, Ninety Mile Beach, 3 Jan., 1987, *I. Crawford 580* (E, MEL); Lakes Entrance, 14 Jan. 1984, *J.H. Ross 2792* (AD, MEL).

Tasmania: Port Dalrymple, [Jan. 1804 (Stearn 1962), *R. Brown* (CANB 279088; K; MEL 543208, labelled as no. 2140 by Bennett and a mixed collection, one element with appressed leaves, the other with longer, non-appressed leaves typical of W.A. collections); Foredunes c. 2 km SE of Badger Head, 6 Feb. 1983, *P.S. Short 1944* (MEL); Preservation Is., Ferneaux Group, 28 Jan. 1978, *J.S. Whinray 1971* (MEL).

### *Notisia* P.S.Short, *gen. nov.*

**Type:** *N. intonsa* (S.Moore) P.S.Short

Annual *herb*, stem and major branches prostrate to erect, cottony. *Leaves* sessile, entire, obovate to oblanceolate, sometimes distinctly spathulate, cottony. *Capitula* heterogamous, woolly, c. 5 or so loosely grouped together at the end of the major axes and short lateral branches, each capitulum subtended by 1 to several cottony to woolly bract-like leaves. *Involucral bracts* 6 or 7, rigid, densely woolly on the outer surface, predominantly herbaceous, not forming a manifestly distinct claw with a terminal, well-delimited hyaline lamina; each of the 2 outer female florets enclosed by a single strongly conduplicate bract enclosing the fruit and the lower ½ of the corolla tube, herbaceous except for hyaline apex; the 2 inner male florets together surrounded by 4 or 5 bracts which are fused for c. ½–⅔ their length, the free portion flat or almost so, mainly green and opaque, the apex and sometimes the margins hyaline. *Female florets* 2, lacking pappus; corolla filiform, apically with several elongate, biseriate hairs on the outer surface; style filiform. *Male florets* 2, lacking ovary and pappus; corolla tubular, 5-lobed; lobes small, with thick margins, 1 or 2 biseriate, elongate, hairs often present on their outer surface, their inner surfaces not papillate at their base; cells of the lobes short and thickened, those of the tube long-rectangular and straight-walled; vascular strands in tube 5, each extending to a sinus between two lobes. *Stamens* 5; filament collar almost straight in outline and not thicker than the filament; anthers prominently caudate, apical appendage obtuse. *Style* with 2 distinct vascular traces from the base but not or barely at all divided into distinct branches, apically truncate and papillate. *Cypselas* monomorphic, narrowly ellipsoid, glabrous, pericarp with 2 vascular bundles, carpopodium annular. *Chromosome number*: unknown.

*Distribution*. Endemic to Western Australia.

*Etymology*. The name is essentially derived from a rearrangement of the letters comprising the specific epithet; it is not an anagram, being minus one letter and having an additional "i".

*Notes*. The structure of the inflorescence is open to interpretation. It perhaps can be considered to be an amalgamation of two capitula, each with a single female floret, surrounding another capitulum with usually two male florets. However, as indicated by the above description, I am inclined to think it is derived from a single heterogamous capitulum in which inner bisexual florets have become functionally male, thus allowing for the fusion of the bracts below the corolla and consequent obliteration of the non-functional gynoecium. That this is the case is supported by the fact that species of Gnaphalieae with separate female and male capitula are almost unknown in Australia, whereas species with heterogamous capitula with outer female florets and inner florets, which are bisexual or male, are common.

The presence of female and male florets and heterogamous capitula readily distinguish this species from all others currently placed in *Gnephosis* s.lat. and many other genera, including all members of the *Angianthus* group (sensu Anderberg 1991), which have only bisexual florets. Although having small, hyaline apices the capitular bracts are not manifestly divided in to a distinct claw with a constriction between it and a terminal lamina. Various other features, singularly or in combination — such as the absence of a pappus and the morphology of the bracts and cypselas — similarly readily distinguish *Notisia* from other gnaphalioid genera with heterogamous capitula.

**1. *Notisia intonsa* (S.Moore) P.S.Short, *comb. nov.***

*Gnephosis intonsa* S.Moore, J. Linn. Soc., Bot. 34: 197 (1899), as "*G. intonsus*", basionym; Grieve & Blackall, How Know W. Austral. Wildfl. 819 (1975). — **Type citation:** "Repperi ad Gibraltar mens. Sep." **Holotype:** Gibraltar, Sep. 1895, *S. Moore* (BM 000810548). **Isotypes:** K 000901816 (photo PERTH), NY 00158206.

Annual *herb*, stem and major branches prostrate to erect, 2.5–15 cm long, cottony. *Leaves* obovate to oblanceolate, sometimes distinctly spathulate, cottony, 3–13 mm long, 0.7–2.1 mm wide. *Capitula* heterogamous, woolly, loosely grouped together at the end of the major axes and short lateral branches, each capitulum subtended by 1 (–several) leafy, cottony to woolly, bract(s). *Involucral bracts* 6 or 7; bracts surrounding female florets strongly conduplicate and enclosing the fruit and the lower ½ of the corolla tube, 2.8–4 mm long, opaque except for a small hyaline apex; bracts surrounding male florets, 3.4–3.7 mm long (including fused bases), the free portion flat or almost so, mainly green, opaque, the apex and sometimes the margins hyaline. *Female corolla* tube 1.5–1.7 mm long. *Cypselas* narrowly ellipsoid, yellowish brown, glabrous, 1.4–1.7 mm long, 0.33–0.45 mm diam. *Male corolla* tube 1.2–1.6 mm long. *Stamens* 5; anthers 0.55–0.62 mm, excluding prominent wide tails c. 0.23–0.29 mm long; microsporangia 0.38–0.49 mm long, apical appendages 0.12–0.19 mm long; filament collar 0.09–0.26 mm long. *Chromosome number*: unknown.

*Distribution*. South-western Western Australia between latitudes c. 29º and 32º S and longitudes 119º and 122ºE.

*Habitat*. The only collectors' notes recording the habitat of this species are "Mixed *Eucalyptus* woodland over *Santalum*/*Eremophila* scrubland on brown stony saline loams" and "gilgai plain; brown cracking clay".

*Phenology & reproductive biology*. The few specimens I have examined were collected from early September to mid-November.

Pollen:ovule ratios, ranging from 292 to 372 ($\bar{x}$ = 350; s.d. = 29; s.e. = 15; n = 5) were determined from 5 capitula, each from a different plant, of *P.S. Short 4040*, a collection gathered south-east of Marvel Loch.

*Typification*. Moore (1899), when describing this and other new species from Western Australia, recorded that his first set of specimens had been allocated to BM, the second to Columbia College, New York (incorporated into NY in 1899), and a third set to K. I accordingly regard the specimen of *G. intonsus* at BM as the holotype (with BM at this time being Moore's unofficial place of work) with isotypes in K and NY. From the JSTOR website (accessed Sep. 2012) it is evident from the isotype at NY that Moore had considered placing the species in *Angianthus*, not *Gnephosis*, but with the same epithet. The specimen at K was received in January 1897 and is mounted on the same sheet as *G.H. Thiselton-Dyer 65*; a photograph of the K sheet is held at PERTH.

*Additional specimens examined.*

Western Australia: 1.3 km E Nepean Mine, 25 Sep. 1986, *R.J. Chinnock 7350* (AD, PERTH); 2.5 km NE of Metzke's Find, 9 Sep. 1988, *R. Cranfield 7292* (MEL, PERTH n.v.); Gibraltar, 4 Oct. 1973, *H. Demarz 4562* (PERTH); Gibraltar, 20 Nov. 1973, *H. Demarz 4888* (PERTH); Twenty miles W of Ravensthorpe, 14 Oct. 1955, *E. Gauba W.A.476* (MEL, PERTH n.v.); 14 km SE of Marvel Loch, 21 Sep. 1979, *K. Newbey 6034* (PERTH); c. 14 km SE of Marvel Loch, 24 Sep. 1993, *P.S. Short 4040* (MEL); No. 8 Pumping Stn, Dedari, 24 miles W of Coolgardie, 1903, *G.H. Thiselton-Dyer 65* (K).

***Trichanthodium* Sond. & F.Muell. ex Sond.**

Linnaea 25: 489 (1853); P.S.Short, Muelleria 7: 213–224 (1990); R.J.Bayer et al. in Kadereit & C.Jeffrey, Fam. Gen. Vasc. Pl. 8: 282 (2006). — **Type:** *T. skirrophorum* Sond. & F.Muell. ex Sond.

Annual *herbs*, branching or simple, glabrous, lanate or tomentose. *Leaves* mainly alternate but lowermost pair(s) opposite, all sessile, entire, usually with a slight mucro, the uppermost with a hyaline apex. *Inflorescence* a compound head; bracts subtending compound heads inconspicuous or the outer ones c. equal to the head; general receptacle flat to convex, glabrous or with long bristles. *Capitula* discoid, homogamous. *Capitular bracts* 1- or 2-seriate, flat to conduplicate, not manifestly differentiated into a distinct claw and terminal lamina, primarily hyaline and yellow in the upper part but at least those of the outer row with an opaque midrib. *Florets* 1 per capitulum, bisexual; corolla tubular, 5-lobed, yellow; style branches truncate; stamens 5, anthers tailed. *Cypselas* monomorphic, obovoid, often somewhat flattened, covered in mucilage-producing cells. *Pappus* an entire truncate cup or a laciniate ring or cup. *Chromosome numbers*: n = 3, 4, ?7.

*Distribution*. An Australian genus with four species; for a distribution map see Short (1990a, Fig. 1).

*Cytology*. Chromosome number determinations for all four species are recorded in Short (1990a) and Watanabe et al. (1999). Excluding an unsubstantiated report by Turner (1970) of $n = 7$ for *T. scarlettianum*, for which I determined $2n = 6$, then only *T. skirrophorum*, the most widespread species, has $n = 4$, the others have $n = 3$.

*Etymology*. From the Greek *trich-* (hair), *anthos* (flower) and *podion* (foot), in reference to the bristly general receptacle of *T. skirrophorum*.

**Key to species of *Trichanthodium***

**1.** General receptacle with bristles . . . . . **1. *T. skirrophorum***
**1:** General receptacle glabrous
  **2.** Leaves tomentose; pappus a truncate cup . . . . . **2. *T. scarlettianum***
  **2:** Leaves glabrous to lanate; pappus a laciniate ring or cup
    **3:** Anthers 0.9–1.2 mm long, apical appendage protruding from the corolla tube at anthesis (W.A.) . **3. *T. exilis***
    **3:** Anthers 0.5–0.8 mm long, apical appendage not manifestly protruding from the corolla tube at anthesis (Vic.) . . . . . **4. *T. baracchianum***

**1. *Trichanthodium skirrophorum* Sond. & F.Muell. ex Sond.**

Linnaea 25: 490 (1853); P.S.Short, Muelleria 7: 218 (1990). — *Gnephosis skirrophora* (Sond. & F.Muell. ex Sond.) Benth., Fl. Austral. 3: 570 (1867). — **Type citation:** "Cudnaka." **Lectotype:** Cudnaka, *F.Mueller* (MEL 542193) (Short 1990a, p. 218). **Probable isolectotypes:** K 000901884; MEL 542194.

*Angianthus codonopappus* F.Muell., Fragm. 9: 2 (1875). — *Gnephosis codonopappa* F.Muell. in Giles, Geog. Travels in Cent. Aust. 217 (1875), nomen nudum; F.Muell., Fragm. 9: 2 (1875), pro syn. — **Type citation:** "In vicinia lacus Eyrei; Giles." **Lectotype:** towards Lake Eyre, 1872, *E.Giles* (MEL 542191) (Short 1990a, p. 218).

*Herb* with branches 3–35 cm long, densely lanate. *Leaves* lanceolate or linear, 5–30 mm long, 0.5–1.2 mm wide, tomentose, grey-green. *Compound heads* broadly depressed ovoid to obloid, 4–12 mm long, 5–15 mm diam., subtended by a general involucre of outer leaf-like bracts and inner hyaline bracts, the longest c. ⅓ as long as the head but inconspicuous in mature heads; general receptacle transversely ellipsoid, bristle. *Capitula* 25–200 per compound head. *Capitular bracts* 5 or 6, outer ones densely hairy at apex, inner 1 or 2 conduplicate, midrib indistinct, glabrous or sparsely hairy at apex. *Cypselas* 1–1.3 mm long. *Pappus* cup-like, 0.6–1.2 mm long. *Chromosome number*: $n = 4$. **Fig. 1F.**

*Distribution*. Widespread across southern and central mainland Australia.

*Habitat*. Frequently in chenopod shrubland in saline and gypseous soil.

*Phenology and reproductive biology*. Flowering c. August to OctoberAn average pollen:ovule ratio of 3,728 has been recorded for this species (Short 1990a).

*Cytology*. Short (1981b), as *Gnephosis skirrophora*, recorded $n = 4$ for a population near Copley, S.A. (*P.S. Short 747*), as had Turner (1970) for populations near Norseman (*B.L. Turner 5563*) and Eucla, both in W.A. Using the name *T. skirrophorum*, Short (1990a) and Watanabe et al. (1999) recorded the same number for three more localities from W.A. (Bulla Bulling, *P.S. Short 1757*; 8 km S of Billabong Roadhouse, *P.S. Short 2834*; Norseman, *K. Watanabe 182*), two more from S.A. (Ceduna, *L. Haegi 2688*; Hawker, *K. Watanabe 202*), and one from Broken Hill, N.S.W. (*K. Watanabe 209*).

*Selected specimens examined.*

Western Australia: 128 miles N of Rawlinna, 12 Oct. 1966, *A.S. George 8468* (PERTH); 8 km S of Billabong Roadhouse, 11 Sep. 1986, *P.S. Short 2834* (AD, MEL, PERTH); c. 3 km from Yalgoo along Paynes Find road, 14 Sep. 1986, *P.S. Short 2908* (MEL, PERTH).

Northern Territory: NW Simpson Desert, 29 Sep. 1973, *P.K. Latz 4394* (AD, DNA).

South Australia: 6.5 km NE of Chilpuddie, 15 Oct. 1967, *H. Eichler 19549* (AD); 15 km W of Leigh Ck, 12 Oct. 1958, *R. Schodde 975* (AD); 10 km W of Blanchetown, 2 Nov. 1971, *D.J.E. Whibley 3755* (AD).

Queensland: Poeppel Corner, 24 Sep. 1966, *D. Boyland 236A* (BRI, MEL, NSW).

New South Wales: 48 km NE of Broken Hill, 16 Oct. 1921, *E.H. Ising* (AD 96935543).

Victoria: 24 km NW of Underbool, 20 Oct. 1983, *J.H. Browne 176* (MEL); 45 km SSW of Mildura, 13 Oct. 1977, *M.D. Crisp 3431* (CANB, MEL).

**2. *Trichanthodium scarlettianum* P.S.Short**

Muelleria 7: 219 (1990). — **Type citation:** "Holotypus: Western Australia, Goulet Bluff, Peron Peninsula … 17.x. 1983, [P.S.] Short 2106 (MEL 1523476). Isotypi: AD, CANB, PERTH."

*Herb* with branches 3–25 cm long, lanate. *Leaves* linear or lanceolate, 5–30 mm long, 0.5–1.1 mm wide, tomentose. *Compound heads* broadly depressed to depressed ovoid, 4.5–6 mm long, 5–11 mm diam., subtended by a general involucre c. ⅓–½ the length of the compound head, inconspicuous in mature heads; general receptacle convex, glabrous. *Capitula* 14–130 per compound head. *Capitular bracts* 4 or 5, outer ones densely hairy at the apex of the midrib, inner ones less hairy and sometimes glabrous. *Cypselas* 1–1.8 mm long. *Pappus* a slightly jagged cup 0.5–1.15 mm long. *Chromosome number*: $n = 3$ and perhaps 7.

*Distribution*. Restricted to the Shark Bay region (including nearby islands) of Western Australia.

*Habitat*. Grows in a variety of plant communities, including beach foredunes near Hamelin Pool, red sand over limestone in *Acacia*- and *Ptilotus*-dominated shrubland, and in clay in low chenopod shrubland.

*Phenology and reproductive biology*. Flowering August to October.

An average pollen:ovule ratio of 6,195 has been recorded for this species (Short 1990a).

*Cytology*. Turner (1970), as "*Calocephalus skirrophora*" recorded $n = 7$ for this species, but this is at variance with a subsequent determination by Short (1990a) of $2n = 6$ for specimens (*P.S. Short 2097*) collected 40 km west of the Overlander Roadhouse, W.A.

*Selected specimens examined.*

Western Australia: Dirk Hartog Is., 2 Sep. 1972, *A.S. George 11381* (CANB, PERTH); 7 km S of Overlander Roadhouse, 20 Aug. 1977, *P.S. Short 420* (AD); 28 km S of Wooramel Roadhouse, 16 Oct. 1983, *P.S. Short 2092* (MEL).

**3. *Trichanthodium exilis* (W.Fitzg.) P.S.Short**

Muelleria 7: 221 (1990). — *Gnephosis exilis* W.Fitzg., J. Western Australia Nat. Hist. Soc. 2: 24 (1905). — **Type citation:** "Minginew, September, 1903.– W.V.F." **Lectotype:** Minginew, Sep. 1903, *W.V. Fitzgerald* (NSW 138835) (Short 1990a, p. 222).

*Herb* with branches 2–20 cm long, almost glabrous to manifestly lanate. *Leaves* narrowly oblong to linear or oblanceolate, 4–11 mm long, 0.7–1.3 mm wide, sometimes slightly succulent, glabrous or lanate. *Compound heads* broadly depressed to depressed ovoid,

spheroid or obloid, 4–11 mm long, 4.5–11 mm diam., subtended by a general involucre c. ⅓–½ the length of the compound head, inconspicuous in mature heads; general receptacle flat to convex, glabrous. *Capitula* 10–200 per compound head. *Capitular bracts* 5 or 6, outer ones densely hairy at the apex of the midrib, inner ones generally less hairy. *Cypselas* 0.9–1.6 mm long. *Pappus* a jagged ring 0.2–0.65 mm long. *Chromosome number*: $n = 3$.

*Distribution*. Western Australia, from about Bunjil and Lake Moore north to Lake Austin.

*Habitat*. Commonly growing in sandy to gypseous soils amongst *Tecticornia* and *Atriplex* around the margins of saline depressions.

*Phenology and reproductive biology*. Flowering about September.

An average pollen:ovule ratio of 5,135 has been recorded for this species (Short 1990a).

*Cytology*. Short (1990a) recorded $2n = 6 + 2Bs$ for a population from Mongers Lake (*P.S. Short 563*) and $n = 3$ for a population at Lake Austin (*P.S. Short 2922*).

*Selected specimens examined.*

Western Australia: c. 3 km from Yalgoo, 1 Sep. 1982, *P.S. Short 1609* (AD, BRI, CANB, DNA, MEL, PERTH); Lake Austin, 14 Sep. 1986, *P.S. Short 2922* (AD, CANB, MEL, NSW, PERTH); c. 6 km S of Warriedar Hmsd, 26 Sep. 1986, *P.G. Wilson 12294* (MEL, PERTH).

**4. *Trichanthodium baracchianum* (Ewart & Jean White) P.S.Short**

Muelleria 7: 222 (1990). — *Gnephosis baracchianum* Ewart & Jean White, Proc. Roy. Soc. Victoria 21: 542, pl. 30 figs 3–8 (1909). — **Type citation:** "Salt swamp near Mission Station, Dimboola. St. Eloy D'Alton." **Lectotype**: MEL 542236 (Short 1990a, p. 222). **Probable isolectotype:** NSW.

*Herb* with branches 1–10 cm long, glabrous or lanate. *Leaves* narrowly oblong to linear, elliptic or ovate to lanceolate, 4.5–12 mm long, 0.5–2.2 mm wide, semi-succulent, with a short mucro, usually glabrous but sometimes sparsely lanate. *Compound heads* depressed ovoid, 4–7 mm long, 5–11 mm diam., subtended by a general involucre usually c. ½ as long as the head and inconspicuous in mature heads but sometimes outer leaf-like bracts about the length of the head; general receptacle convex, glabrous. *Capitula* 8–50 per compound head. *Capitular bracts* 4–7, outer ones densely hairy at apex, inner ones sparsely hairy at apex. *Cypselas* 1.3–1.5 mm long. *Pappus* a jagged ring 0.3–0.4 mm long. *Chromosome number*: $n = 3$.

*Distribution*. A species endemic to western Victoria, found in saline regions in a narrow band from about Jeparit south to Mitre Flora & Fauna Reserve.

*Habitat*. Halophytic communities on the edge of saline flats.

*Phenology and reproductive biology*. Flowering October to November.

An average pollen:ovule ratio of 891 has been recorded for this species (Short 1990a). The recorded range was 404–1,526 and I am of the opinion that counts of less than 1,000 may not be the norm, such numbers having been determined from last-formed florets and/or small, somewhat water-stressed plants.

*Cytology*. Chromosome numbers of $n = 3$ and $2n = 6$ have been reported for this species from specimens collected near Antwerp (Short 1990a, Watanabe et al. 1999).

*Selected specimens examined.*

Victoria: Mitre Flora & Fauna Res., 11 Nov. 1986, *A.C. Beauglehole 86523* (MEL); 3.5 km W of Antwerp, 26 Oct. 1983, *N.H. Scarlett 83/266* (MEL); c. 4 km W of Antwerp, 15 Oct. 1988, *P.S. Short 3338* (MEL).

## Excluded names

***Calocephalus chrysanthes* Schltdl.**

Linnaea 20: 592 (1847). Type: "Vom Grubenlande bei Bethanien. December." [Behr].
= ***Pycnosorus chrysanthus*** (Schltdl.) Sond., Linnaea 25: 492 (1853); J.Everett & A.N.Doust, Telopea 5: 39 (1992).

***Calocephalus globosus* M.B.Scott & Hutch.**

Kew Bull. 1916: 36 (1916). Type: "Western Australia. Kauring, on the York-Greenhills line, *Stoward 505*." (holo: K).
= ***Rhodanthe spicata*** (Steetz) Paul G.Wilson, Nuytsia 8: 413 (1992).

***Calocephalus gnaphalioides* Hook. in T.Mitch.**

J. Exped. Int. Trop. Austral. 378(1849). Type: not cited.
= ***Rhodanthe moschata*** (Cunn. ex DC.) Paul G. Wilson, Nuytsia 8: 385 (1992).

***Gnephosis burkittii* Benth.**

Fl. Austral. 3: 570 (1867). Type: "S. Australia. Lake Gillies, Burkitt."
= ***Lemooria burkittii*** (Benth.) P.S.Short, Muelleria 7: 112 (1989). — Additional synonym: *Angianthus burkittii* (Benth.) J.M. Black, Fl. S. Austral. 4: 645, pl. 53 (1929). **Fig. 2E.**

***Gnephosis pygmaea* (A.Gray) Benth.**

Fl. Austral. 3: 572 (1967).
= ***Myriocephalus pygmaeus*** (A.Gray) P.S.Short in W.R. Elliot & D.L.Jones, Encyc. Australian Pl. 6: 471 (1993) (as "pygmaea"); P.S. Short, Austral. Syst. Bot. 13: 735 (2000). — Basionym: *Crossolepis pygmaea* A.Gray, Hooker's J. Bot. & Kew Gard. Misc. 3: 177 (June 1851). Type: "South-western Australia, Drummond." **Fig. 2F.**

***Gnephosis rotundifolia* Diels**

Bot. Jarb. 35: 614, fig. 69k–n (1905). Type: "Hab. in distr. Stirling pr. locum quem vocant 'The Pass' in declivis lapidosis solo lutoso-arenoso flor. M. Oct. (D. 4600)."
= ***Stuartina muelleri*** Sond., Linnaea 25: 522 (1853); Grieve & Blackall, How Know W. Austral. Wildfl. 853 (1975); H.I.Aston & D.A.Cooke, Muelleria 6(4): 256 (1986), lectotypification; P.S.Short in N.G.Walsh & Entwisle, Fl. Victoria 4: 819 (1999).

## Acknowledgements

My interest in the compound-headed daisies commenced in 1977 when I began studying the group for my Ph.D. and, even when later involved in studies of *Brachyscome*, when opportunities arose I continued to collect them. As such, field work has been funded by a number of grants and organisations, including Australian Biological Resources Study (ABRS), the National Herbarium of Victoria and, indirectly, by Japanese research grants to Professor Kuniaki Watanabe (Nabe) with whom I collaborated on cytological studies of Australian Astereae and Gnaphalieae. As well as Nabe and his colleagues and students, I have enjoyed the company and help from many people in the field, including Michael Amerina, Bill and Robyn Barker, Bob Chinnock, Margaret Corrick, Stephen Forbes, Bruce Fuhrer, Laurie Haegi, Nicholas Lander, Mike Looker, Jim Ross, Neville Walsh and, last but by no means least, my wife Emma. Deborah Bisa and volunteer Michael Michie at DNA provided the photographs of the type specimens. The list would be long, and in may cases I do not know who would have been involved, so thank you too, to every one else who has assisted in helping in the production of this review, especially those who collected specimens and were involved in the often tedious task of mounting specimens and dealing with loans. And finally, I thank Jürgen Kellermann for his diligent editorial work.

## References

Anderberg, A.A. (1991). Taxonomy and phylogeny of the tribe Gnaphalieae (Asteraceae). *Opera Botanica* 104: 1–195.

Baines, J.A. (1981). *Australian plant genera*. (Society for Growing Australian Plants & Surrey Beatty & Sons Pty Ltd: Chipping Norton).

Barker, R.M. (2005). James Drummond's plant collections today – a global dispersal. In: Davies, S.J.J.F. (ed.), *The Drummond Symposium. A review of the work of James Drummond, the first Government Botanist in Western Australia*, pp. 40–57. (Curtin University of Technology: Perth). [*Department of Environmental Biology Bulletin* no. 27].

Barker, W.R., Badman, S., Badman, E., Black, A.B., Harris, C.R. & Read, J.L. (2016). Frank Badman, ouback scientist 29 June 1943–26 September 2015. *Australasian Systematic Botany Society Newsletter* 166: 24–31.

Bayer, R.J., Breitwieser, I., Ward, J.M. & Puttock, C.F. (2006, dated 2007). Gnaphalieae. In: Kadereit, J.W. & Jeffrey, C. (eds), *The families and genera of vascular plants* 8: 246–284. (Springer: Berlin).

Bayer, R.J., Greber, D.G. & Bagnall, N.H. (2002). Phylogeny of Australian Gnaphalieae (Asteraceae) based on chloroplast and nuclear sequences, the *trnL* intron, *trnL/trnF* intergenic spacer, *matK*, and ETS. *Systematic Botany* 27: 801–814.

Beard, J.S. (1990). *Plant life of Western Australia*. (Kangaroo Press: Kenthurst, N.S.W.).

Bentham, G. (1837). *Crossolepis* Less. In: Endlicher, S.L., Bentham, G., Fenzl, E., & Schott, H., *Enumeration plantarum quas in Novae Hollandiae ora austro-occidentali ad fluvium Cygnorum et in sinu Regis Georgii collegit Carolus Liber Baro de Hügel*, p. 61 (Friedrich Beck: Wien).

Bentham, G. (1863). Preface. In: *Flora Australiensis*: *a description of the plants of the Australian territory* 1: 7*–18*. (Lovell Reeve & Co.: London).

Bentham, G. (1867a, dated 1866). Compositae. In: *Flora Australiensis*: *a description of the plants of the Australian territory*. 3: 447–680. (Lovell Reeve & Co.: London).

Bentham (1867b). Letter to F. Mueller, dated 17 Nov. 1867. RB MSS M4, Library, Royal Botanic Gardens, Melbourne. [Quoted by J.H. Ross, *Muelleria* 23: 35–36 (2006).]

Birch, C.W. (1872). A valuable work. *The Brisbane Courier*, Saturday, April 20, p. 6. trove.nla.gov.au/ndp/del/article/1303760?searchTerm=Charles%20Weldon%20de%20Burgh%20Birch&searchLimits [accessed 8 Mar., 2012].

Black, J.M. (1918). Addition to the Flora of South Australia. No. 13. *Transactions & Proceedings of the Royal Society of South Australia* 42: 38–61.

Black, J.M. (1929). Compositae. In: *Flora of South Australia* 4: 570–662. (Govt Printer: Adelaide).

Brosse, J. (1983). *Great voyages of exploration*. (Double Day Australia: Lane Cove).

Brown, E.A. (1992). *Calocephalus* R.Br. In: Harden, G.J. (ed.), *Flora of New South Wales* 3: 258–259 (University of New South Wales Press: Kensington).

Brown, R. (1817). Observations on the natural family of plants called Compositae. *Transactions of the Linnean Society* 12: 75–142. [Preprint before Sep. 1817, journal 25 Feb. 1818.]

Brummitt, R.K. & Powell, C.E. (1992). *Authors of plant names*. (Royal Botanic Gardens: Kew).

Candolle, A.P. (1838). *Prodromus systematis naturalis regni vegetabilis*. Volume 6. (Treuttel & Würtz: Paris).

Cassini, A.H.G. (1820). Description d'un nouveau genre de plantes (*Hirnellia*). *Bulletin des Sciences par la Societe Philomatique de Paris* 1820: 57–58.

Cassini, A.H.G. (1823). "*Leucophyte*" [sic]. In: Cuvier, G.-F., *Dictionnaire des sciences naturelles* 26: 158–161. (Leverault & Le Normant: Paris & Strasbourg).

Chapman, A.D. (1991). *Australian plant name index*, 4 vols. (Australian Government Publishing Service: Canberra). [*Australian Flora & Flora Series* 12–15].

Cornell, C. (1974). English translation of *The journal of Post Captain Nicolas Baudin, Commander-in-Chief of the Corvettes Géographe and Naturaliste*. (Libraries Board of South Australia: Adelaide).

Cruden, R.W. (1977). Pollen-ovule ratios: a conservative indicator of breeding systems in flowering plants. *Evolution* 31: 32–46.

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. & Leigh, J.H. (1981). *Plants of western New South Wales*. (Soil Conservation Service of N.S.W. & N.S.W. Govt Printing Office: Sydney).

Daley, C. (1927). The history of *Flora Australiensis*. *Victorian Naturalist* 44: 63–69, 90–100, 127–138, 153–165, 183–187, 212–221, 271–278.

Davis, C. & Lee, D.J. (1944). The type concept in taxonomy. *The Australian Journal of Science* 7: 16–19.

Davis, G.L. (1948). Revision of the genus *Brachycome* Cass. Part. I. Australian species. *Proceedings of the Linnean Society of New South Wales* 73: 142–241.

Elliot, W.R. & Jones, D.L. (1982). *Encyclopaedia of Australian plants suitable for cultivation* 2: 432–433. (Lothian Publishing Company Pty Ltd: Port Melbourne).

Elliot, W.R. & Jones, D.L. (1993). *Encyclopaedia of Australian plants suitable for cultivation* 6: 147. (Thomas C. Lothian Pty Ltd: Port Melbourne).

Erickson, R. (1969). *The Drummonds of Hawthornden*. (Lamb Paterson: Osborne Park, Perth).

Everett, J. & Doust, A.N.L. (1992). New species and a new combination in *Pycnosorus* (Asteraceae: Gnaphalieae). *Telopea* 5: 39–43.

Flann, C., Greuter, W. & Hind, D.J.N. (2010). Cassini's Compositae genera: a nomenclatural and taxonomic assessment. *Taxon* 59: 1206–1244.

George, A.S. (2009). *Australian botanist's companion*. (Four Gables Press: Kardinya, W.A.).

Grandison, R. (1990). The 1851 botanical excursion of Ferdinand Mueller to the Flinders Ranges, South Australia. In: Short, P.S. (ed.), *History of systematic botany in Australasia*, pp. 109–113. (Australian Systematic Botany Society: Melbourne).

Gray, A. (1851a). Characters of some Gnaphalioid Compositae of the division Angiantheae. *Hooker's Journal of Botany & Kew Garden Miscellany* 3: 97–102, 147–153, 172–178.

Gray, A. (1851b). *Dimorpholepis australis*, *Diotosperma drummondii* & *Scyphocoronis viscosa*. *Hooker's Icones Plantarum* 9: pl. 854–856.

Gray, A. (1852). Characters of some Gnaphalioid Compositae of the division Angiantheae. *Hooker's Journal of Botany & Kew Garden Miscellany* 4: 225–232, 266–276.

Gray, J.L. (ed.) (1894). *Letters of Asa Gray.* (Houghton, Mifflin & Co.: Boston & New York).

Green, J. (1985). *Census of the vascular plants of Western Australia*, 2nd ed. (Western Australian Herbarium, Department of Agriculture: Perth).

Grieve, B.J. (1982). *How to know Western Australian wildflowers*, Part 4: *Supplement.* (University Western Australia Press: Nedlands).

Grieve, B.J. & Blackall, W.E. (1975). *How to know Western Australian Wildflowers*, Part 4. (University Western Australia Press: Nedlands).

Jacobs, S.W.L. & Pickard, J. (1981). *Plants of New South Wales*. (Government Printer: Sydney).

Jeffrey, C. (2006, dated 2007). Introduction with key to tribes. In: Kadereit, J.W. & Jeffrey, C. (eds), *The families and genera of vascular plants* 8: 61–87. (Springer: Berlin).

Keighery, G.J. (2002). A new species of *Blennospora* (Asteraceae: Gnaphalieae) from the Swan River and Scott Coastal Plains of Western Australia. *Nuytsia* 15: 33–36.

Kenneally, K.F. (1988). Obituary: Ken Newbey (1936–1988). *Western Australian Naturalist* 17: 126–127.

Konishi, N., Watanabe, K. & Kosuge, K. (2000). Molecular systematics of Australian *Podolepis* (Asteraceae: Gnaphalieae): evidence from DNA sequences of the nuclear ITS region and the chloroplast matK gene. *Australian Systematic Botany* 13: 709–727.

Lawrence, M.E. (1985). *Senecio* L. (Asteraceae) in Australia: reproductive biology of a genus found primarily in unstable environments. *Australian Journal of Botany* 33: 197–208.

Lessing, C.H. (1832). *Crossolepis* Less. In: *Synopsis Generum Compositarum*, p. 270. (Dunker & Humblot: Berlin).

McCusker, A. (1999). Glossary. In: Orchard, A.E. & Thompson, H.S. (executive eds), *Flora of Australia* 1 (2nd ed.): 585–636. (ABRS/CSIRO: Melbourne).

McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersema, J.H., & Turland, N.J. (eds) (2012). *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code): Adopted by the Eighteenth International Botanical Congress Melbourne, Australia.* (Koeltz Scientific Books: Königstein, Germany). [*Regnum Vegetabile* 154].

Marchant, N.G. (1990). The contribution of the Russian botanist Turczaninov to Australian plant taxonomy. In: Short, P.S. (ed.), *History of systematic botany in Australasia*, pp. 121–130. (Australian Systematic Botany Society: Melbourne).

Marzinek, J., De-Paula, O.C. & Oliveira, D.M.T. (2008). Cypsela or achene? Refining terminology by considering anatomical and historical factors. *Revista Brasileira de Botânica* 31: 549–553.

Moore, S. (1899). The botanical results of a journey into the interior of Western Australia; with some observations on the nature and relations of the desert flora. *Journal of the Linnean Society, Botany* 34: 171–261.

Mueller, F.J.H. (1882). *Systematic census of Australian plants, with chronologic, literary and geographical annotations*, Part 1: *Vasculares.* (M'Carron, Bird & Co.: Melbourne).

Mueller, F.J.H. (1888). *Key to the system of Victorian Plants*, Vol. 1: *Dichotomous arrangement of the orders, genera and species*. (Govt Printer: Melbourne).

Orchard, A.E. (1999). A history of systematic botany in Australia. In: Orchard, A.E. & Thompson, H.S. (executive eds), *Flora of Australia* 1 (2nd ed.): 11–103. (ABRS/CSIRO: Melbourne).

Radford, A.E., Dickison, W.C., Massey, J.R. & Bell, C.R. (1974). *Vascular plant systematics*. (Harper & Row: New York).

Roque, N., Keil, D.J. & Susanna, A. (2009). Illustrated glossary of Compositae. In: Funk, V.A., Susannna, A., Stuessy, T.F. & Bayer, R.J. (eds), *Systematics, evolution and biogeography of Compositae*, pp. 781–806. (International Association for Plant Taxonomy: Vienna).

Schaumann, M., Barker, J. & Greig, J. (1987). *Australian daisies for gardens and floral art*. (Lothian Publishing Company Pty Ltd: Melbourne).

Short, P.S. (1981a). Pollen:ovule ratios, breeding systems and distribution patterns of some Australian Gnaphaliinae (Compositae: Inuleae). *Muelleria* 4: 395–417.

Short, P.S. (1981b). *Biosystematic studies in Australian Gnaphaliinae (Compositae: Inuleae)*. (Ph.D. thesis, Flinders University of South Australia).

Short, P.S. (1981c). *Gnephosis* & *Calocephalus*. In: Jessop, J.P. (ed.-in-chief), *Flora of Central Australia*, pp. 389–392. (Reed: Sydney).

Short, P.S. (1983). A revision of *Angianthus* Wendl. sensu lato (Compositae: Inuleae: Gnaphaliinae). *Muelleria* 5: 143–214.

Short, P.S. (1985). A revision of *Actinobole* Fenzl ex Endl. (Compositae: Inuleae: Gnaphaliinae). *Muelleria* 6: 9–22.

Short, P.S. (1986a). *Blennospora*, *Calocephalus* & *Gnephosis*. In: Jessop, J.P. & Toelken, H.R. (eds), *Flora of South Australia* 3: 1500–1504, 1519–1521. (Govt Printer: Adelaide).

Short, P.S. (1986b). Chromosome number reports in Australian Asteraceae. *Taxon* 35: 610.

Short, P.S. (1986c). A revision of *Pogonolepis* Steetz (Compositae: Inuleae: Gnaphaliinae). *Muelleria* 6: 237–253.

Short, P.S. (1987a). A revision of *Blennospora* A.Gray (Compositae: Inuleae: Gnaphaliinae). *Muelleria* 6: 349–358.

Short, P.S. (1987b). Notes on *Gnephosis* Cass. (Compositae: Inuleae: Gnaphaliinae). *Muelleria* 6: 317–319.

Short, P.S. (1989a). A revision of *Podotheca* Cass. (Asteraceae: Inuleae: Gnaphaliinae). *Muelleria* 7: 39–56.

Short, P.S. (1989b) New genera and species of Australian Inuleae (Asteraceae). *Muelleria* 7: 103–116.

Short, P.S. (1990a). A revision of *Trichanthodium* Sond. & F.Muell. ex Sond. (Asteraceae: Inuleae: Gnaphaliinae). *Muelleria* 7: 213–224.

Short, P.S. (1990b). A revision of the genus *Chthonocephalus* Steetz (Inuleae: Asteraceae). *Muelleria* 7: 225–238.
Short, P.S. (1990c). New taxa and new combinations in Australian Gnaphaliinae (Inuleae: Asteraceae). *Muelleria* 7: 239–252.
Short, P.S. (1990d). What price a herbarium specimen? *Australian Systematic Botany Society Newsletter* 63: 4–8.
Short, P.S. (1995a). A revision of *Millotia* (Asteraceae-Gnaphalieae). *Australian Systematic Botany* 8: 1–47.
Short, P.S. (1995b). Cladistic analysis of *Millotia* (Asteraceae-Gnaphalieae). *Australian Systematic Botany* 8: 49–55.
Short, P.S. (2000). Notes on *Myriocephalus* Benth. s.lat. (Asteraceae: Gnaphalieae). *Australian Systematic Botany* 13: 729–738.
Short, P.S. (2014). A taxonomic review of *Brachyscome* Cass. s.lat. (Asteraceae: Astereae), including descriptions of a new genus, *Roebuckia*, new species and new infraspecific taxa. *Journal of the Adelaide Botanic Gardens* 28: 1–219.
Short, P.S. & Sinkora, D.M. (1988). The botanist Joachim Steetz (1804–1862). *Muelleria* 6: 449–494.
Short, P.S., Wilson, K.E. & Nailon, J. (1989). Notes on the fruit anatomy of Australian members of the Inuleae (Compositae). *Muelleria* 7: 57–79.
Stafleu, F.A. & Cowan, R.S. (1976–1988). *Taxonomic literature,* 2nd ed. (Bohn, Scheltema & Holkema: Utrecht).
Stearn, W.T. (1962). *Three prefaces on Linnaeus and Robert Brown*. (J. Cramer: Weinheim).
Stearn, W.T. (1983). *Botanical Latin* (ed. 3). (David & Charles Publishers: Newton Abbot, Devon).
Steetz, J. (1845). *Leucophyta* R.Br. In: Lehmann, J.G.C. (ed.), *Plantae Preissianae sive enumeratio plantarum, quas in Australasia occidentali et meridionali-occidentali annis 1830–1841 collegit Ludwig Preiss* 1: 442–443. (Meissner: Hamburg).
Systematics Association Committee for Descriptive Terminology (1962). Terminology of simple symmetrical plane shapes (Chart 1). *Taxon* 11: 145–156, 245–247.
Thiers, B. (continuously updated). *Index Herbariorum*: *a global directory of public herbaria and associated staff*. (New York Botanical Garden's Virtual Herbarium: New York). sweetgum.nybg.org/science/ih [last accessed: 3 Dec. 2015].
Turczaninow, N. (1851). Synanthereae quaedam hucusque indescriptae. *Bulletin de la Société Imperiale des Naturalistes de Moscou* 24(1, 1): 166–214; 24(2, 3): 59–95.
Turner, B.L. (1970). Chromosome numbers in the Compositae. XII. Australian species. *American Journal of Botany* 57: 382–389.
Underwood, R. (2011). *A botanical journey: The story of the Western Australian Herbarium.* (Department of Environment & Conservation: Perth).
Walsh, N.G. (2007). A revision of *Eriochlamys* (Asteraceae, Gnaphalieae). *Muelleria* 25: 101–114.
Ward, J., Bayer, R.J., Breitwieser, I., Smissen, R., Galbany-Casals, M. & Unwin, M. (2009). Gnaphalieae. In: Funk, V.A., Susannna, A., Stuessy, T.F. & Bayer, R.J. (eds), *Systematics, evolution and biogeography of Compositae*, pp. 539–588. (International Association for Plant Taxonomy: Vienna).
Watanabe, K., Short, P.S., Denda, T., Konishi, N., Ito, M. & Kosuge, K. (1999). Chromosome number determinations and karyotypes in the Australian Gnaphalieae and Plucheeae (Asteraceae). *Australian Systematic Botany* 12: 781–802.
Weber, X.A. & Schmidt-Lebuhn, A.N. (2015). Generic boundaries of *Leucochrysum* and *Waitzia* (Asteraceae: Gnaphalieae). *Australian Systematic Botany* 28: 203–218.
Willis, J.H. (1952). Notes on some Australian Compositae. *Proceedings of the Royal Society of Queensland* 62: 101–107.
Willis, J.H. (1962). The botany of the Victoria Exploring Expedition (September 1860–June 1861) and of relief contingents from Victoria (July 1861–November 1862). *Royal Society of Victoria* 75: 247–268.
Wilson, P.G. (1989a). A revision of the genus *Hyalosperma* (Asteraceae: Inuleae: Gnaphaliinae). *Nuytsia* 7: 75–101.
Wilson, P.G. (1989b). *Eromyophyllum* (Asteraceae: Inuleae: Gnaphaliinae), a new Australian genus in the *Helipterum* complex. *Nuytsia* 7: 103–116.
Wilson, P.G. (1992a). The *Lawrencella* complex (Asteraceae: Gnaphalieae: Angianthinae) of Australia. *Nuytsia* 8: 361–377.
Wilson, P.G. (1992b). The classification of Australian species currently included in *Helipterum* and related genera (Asteraceae: Gnaphalieae): Part 1. *Nuytsia* 8: 379–438.
Wilson, P.G. (1992c). The classification of Australian species currently included in *Helipterum* (Asteraceae: Gnaphalieae): Part 2: *Leucochrysum*. *Nuytsia* 8: 439–446.
Wilson, P.G. (2016). A taxonomic treatment of *Chrysocephalum apiculatum* and *C. semipapposum* (Asteraceae: Gnaphalieae). *Nuytsia* 27: 33–73.

## Index to Scientific Names

New names, including new combinations, are in **bold**. Other accepted names are in ***bold italic***. Synonyms, misapplied, misspelt, illegitimate, invalid, excluded and names of uncertain application are in *italics*. Page numbers in **bold** refer to the main taxonomic treatment. Page numbers preceded with an asterisk refer to figures.